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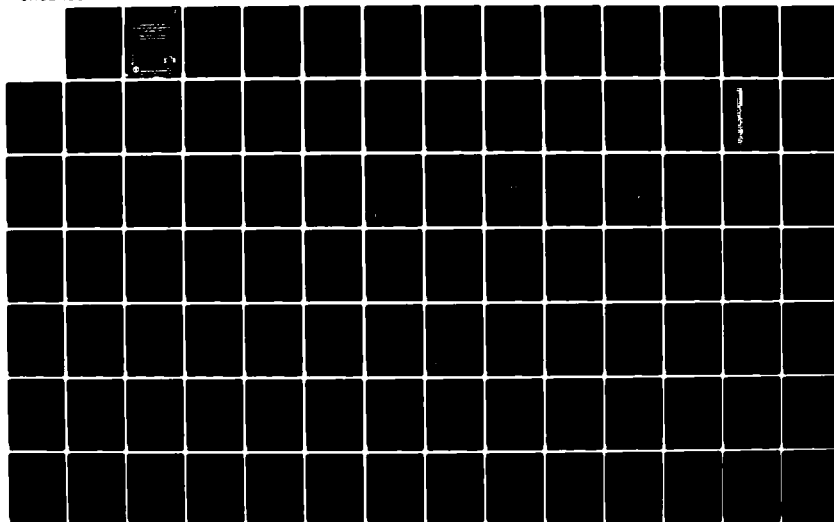
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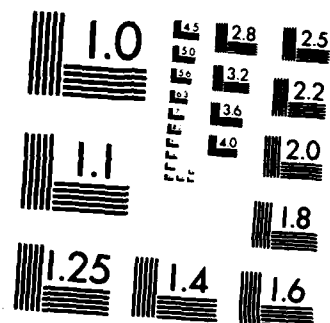
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ASSESSMENT OF THE POTENTIAL FOR GROUNDWATER CONTAMINATION

Edwards Air Force Base Disposal Site Evaluations

**U.S. Department of Defense
U.S. Air Force**

DISC

INSTALLATION RESTORATION PROGRAM
IRP Phase I

ASSESSMENT OF THE POTENTIAL FOR
GROUNDWATER CONTAMINATION

Edwards Air Force Base Waste
Disposal Site Evaluations

Contract Number F08637 80 G0002

U. S. Department of Defense
U. S. Air Force

Envirodyne Engineers, Inc.
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<p>THIS REPORT EVALUATES THE POTENTIAL FOR GROUNDWATER CONTAMINATION AT NINE HAZARDOUS WASTE STORAGE AND DISPOSAL SITES. AT EDWARDS AFB, CALIFORNIA. THIS EVALUATION CONSISTED OF AN INITIAL ASSESSMENT SURVEY BASED ON PUBLISHED AND UNPUBLISHED REPORTS AND RECORDS, INTERVIEWS WITH BASE PERSONNEL, CONSULTATION WITH FEDERAL, STATE AND LOCAL AGENCIES, AND SITE INSPECTIONS. THIS EFFORT WILL BE FOLLOWED BY THE INSTALLATION RESTORATION PROGRAM PHASE II, FIELD INVESTIGATION AND PROBLEM DEFINITION.</p>					
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EXECUTIVE SUMMARY

✓ Envirodyne Engineers, Inc. (EEI) evaluated the potential for groundwater contamination at nine hazardous waste storage and disposal sites at Edwards Air Force Base, California. This evaluation consisted of an Initial Assessment Survey based on published and unpublished reports and records, interviews with base personnel, consultation with federal, state and local agencies, and site inspections.

✓ Five of the nine sites have little or no potential for groundwater contamination. Two of the remaining four sites, the Industrial Waste Pond and the Main Base Toxic Waste Disposal Site, may have a limited potential for contamination of groundwater. The industrial Waste Pond may or may not contain toxic organics. If such contaminants are present, there is a mechanism to transport them to an aquifer. At the Main Base Toxic Waste Disposal Site, saturated soils may be present beneath the site. If so, there is a limited potential for the slow migration of contaminants from that site toward an aquifer.

→ The remaining two sites, the North Lake Bed Storage and Disposal Site and the South Base Waste POL Storage Site, have significant potential to contaminate groundwater. At the North Lake Bed site, two subsites are in physical environments which

↓
are susceptible to groundwater contamination. Groundwater contamination at these subsites needs to be verified and the wastes removed. At the South Base Waste POL Storage Area, groundwater contamination may have already occurred or may occur in the future. Groundwater in the immediate vicinity of this site should be monitored to detect contamination before it migrates.

CHAPTER 1

INTRODUCTION

In September, 1980, Envirodyne Engineers, Inc. was retained by the U. S. Air Force, Tyndall Air Force Base, Florida, to conduct an evaluation of several Hazardous Waste Disposal and Storage Sites at Edwards Air Force Base, California. This evaluation was conducted during the latter part of 1980; the results of this evaluation are presented in this report.

The purpose of this study was to identify and evaluate the potential for groundwater contamination from past waste disposal practices at Edwards Air Force Base, and to identify remedial alternatives if such potential exists. The information used to make this evaluation was obtained from published and unpublished reports, interviews with Edwards Air Force Base personnel, consultation with federal, state and local regulatory and research agencies, and visits to the sites.

Chapters 2, 3 and 4 of this report describe the physical setting of Edwards Air Force Base. Chapter 5 contains a detailed description of each of the hazardous waste disposal and storage sites, and an analysis of the potential for groundwater contamination at each site. Chapter 6 contains a summary of EEI's recommendations for mitigative or remedial actions at each site.

CHAPTER 2

PHYSICAL SETTING

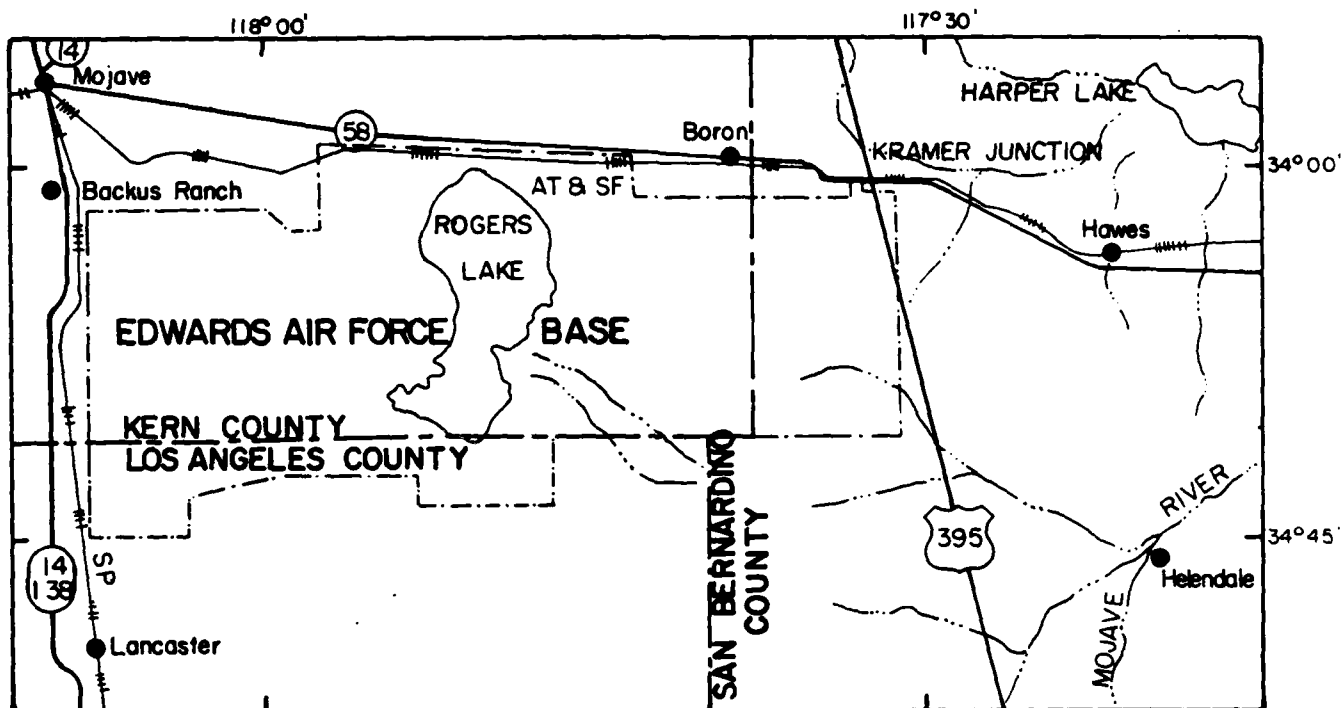
Edwards AFB lies in the geologic area known as the Mojave Desert Province (Willems, et al., 1964) (see Figure 1). The Mojave is typically described as a broad flat plain with occasional relief. Edwards AFB is located in an area of the desert known as Antelope Valley.

Twelve geologic units have been defined in the vicinity of the base (Dutcher, 1960), and these are shown in Figure 2 (in pocket). These units and their map symbols are shown in Table 1. Of these twelve units, the three tertiary units (Basalt, Felsic Volcanic rocks, and Continental and Sedimentary rocks) have only very limited exposure within the boundary of Edwards AFB, and will not be described in detail. The other nine units are described below.

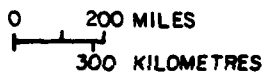
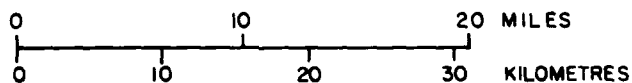
ALLUVIUM

Younger and Older Alluvium (Qya and Qoa)

Alluvium underlies the undissected alluvial surfaces of the lower valley areas. Alluvium is exposed between the lower margins of alluvial fans and the upper edges of the playas and in creek beds and arroyos. It has a greater areal extent than any other unit in the water-bearing group. Alluvium increases



Base from U.S. Geological Survey State of California
(South Half) 1:500,000



INDEX MAP



TABLE 1

GEOLOGIC UNITS IN THE EDWARDS AFB AREA*

<u>Unit Name</u>	<u>Map Symbol</u>	<u>Description</u>
<u>Holocene</u>		
Younger Alluvium	Qya	Gravel, sand, silt and clay beneath alluvial plains.
Younger Fan Deposits	Qyf	Poorly sorted gravel, sand, silt and mudflow debris, locally derived.
Playa Deposits	Qp	Silt and clay beneath lakebeds.
Lakeshore Deposits	Qls	Gravel and sand and some silt and clay.
Dune Sand	Qds	Sand, actively drifting.
<u>Pleistocene</u>		
Older Alluvium	Qoa	Generally weathered arkosic gravel, sand, silt and clay.
Old Windblown Sand	Qos	Unconsolidated to moderately indurated sand; largely inactive.
Older Fan Deposits	Qof	Moderately to highly indurated boulder gravel, cobble-pebble gravel, and sand.
<u>Tertiary</u>		
Basalt	Tb	Extrusive amygdaloidal olivine basalt and intrusive diabasic basalt.
Felsic Volcanic Rocks	Tav	Quartz latite, some andesite, rhyolite, and dacite.
Continental and Sedimentary Rocks	Tc	Conglomerate, sandstone, siltstone, shale, limestone and water-laid tuff and agglomerate.
<u>Pre-Tertiary</u>		
Basement Complex, undifferentiated	pTu	Quartz monzonite and some granite, gneiss, schist, metavolcanics, and pegmatite dikes, locally deeply weathered.

*See Figure 2

in thickness from the edges of the basins to their center. The central portions of the basins are underlain by unconsolidated alluvial debris probably more than 1,000 feet thick deposited from late Pleistocene to Recent time (Willets et al., 1964).

Alluvial deposits are formed in stream channels and associated floodplains of individual streams, or as broad alluvial plains where stream braiding dominates an appreciable area (Krumbein and Sloss, 1963). Both types of deposits occur in the Edwards AFB area.

In any single stream, the deposits develop as elongate lenses, generally oriented downstream. The more permeable strata occur in stringers and lenses that are usually surrounded by less permeable sediments. Such stringers and lenses were deposited in the channels of streams which gradually filled the basins with alluvial material. While the stream channels were being filled with sand and gravel, surrounding interstream areas received only fine deposits from sheet flooding and overflowing of the stream channels. On alluvial plains, the master streams may braid into numerous channels which form inter-tonguing lenses or small sheets of sediment characterized by cut-and-fill structures and abrupt changes in particle size.

From bed to bed, the textural gradations appear to be irregular, but systematic sampling shows a progressive change from coarse material at the heads of the valleys to increasingly finer material downslope (Krumbein and Sloss, 1963). This change in particle size corresponds to an overall decrease in permeability in the downslope direction. Weathering has also increased the amount of residual clay in the deposits. Thus, weathering and these various modes of deposition account partly for the non-homogeneous distribution of the alluvium (Willems, et al., 1964). This non-homogeneity results in large differences in both permeability and groundwater velocity within very short distances (Freeze and Cherry, 1979).

The principal water-bearing sediments in the region are usually found in the alluvial deposits. The water-bearing sediments are neither compacted nor cemented, and the sands and gravels are usually permeable. Much of the Younger Alluvium lies above the water table and, though highly permeable, is typically not considered to be a reliable source of water for wells (Willems, et al., 1964).

ALLUVIAL FANS

Younger and Older Fan Deposits (Qyf and Qof)

The alluvial fans are water-transported sediments which settled out when the water carrying the material suddenly changed velocity from rapid to slow. Alluvial fans are located

at the foot of mountains where channelized fast flowing streams contact the broad plains and drop their sediment loads. The principal constituent of the alluvial fans is fanglomerate which is a poorly sorted, well graded granular material. Fanglomerate is a material which contains all grain sizes, i.e., boulders to clay. Because it is poorly sorted, this material tends to be less permeable than a clean sand but more permeable than clays. The Younger Fan deposits typically tend to lie above the water table. Even where saturated, the fan deposits (Younger and Older) yield little water to wells and are not considered major aquifers (Willets et al., 1964).

WINDBLOWN SAND

Dune Sand and Old Windblown Sand (Qds and Qos)

The surficial areas surrounding the lake beds are generally eolian sand dunes, some of which (Old Windblown Sand) have been stabilized by vegetation. The grain size of the dunes ranges from very fine to coarse. The sand dunes usually are a few feet thick, but in some areas they may be 10 to 20 feet thick. Some large deposits occur along the periphery of the dry lakes. Many of the smaller dunes were formed by deflation of the Recent alluvium, older sediments, or playa deposits (Willets et al., 1964). The dune sand deposits usually lie above the water table and are unsaturated. However, they are porous and permeable and will readily absorb water falling on

their surfaces. This water can then migrate to underlying sediments (Willets, et al., 1964). However, that does not necessarily mean that the water will be transmitted through or into the underlying sediments or aquifer.

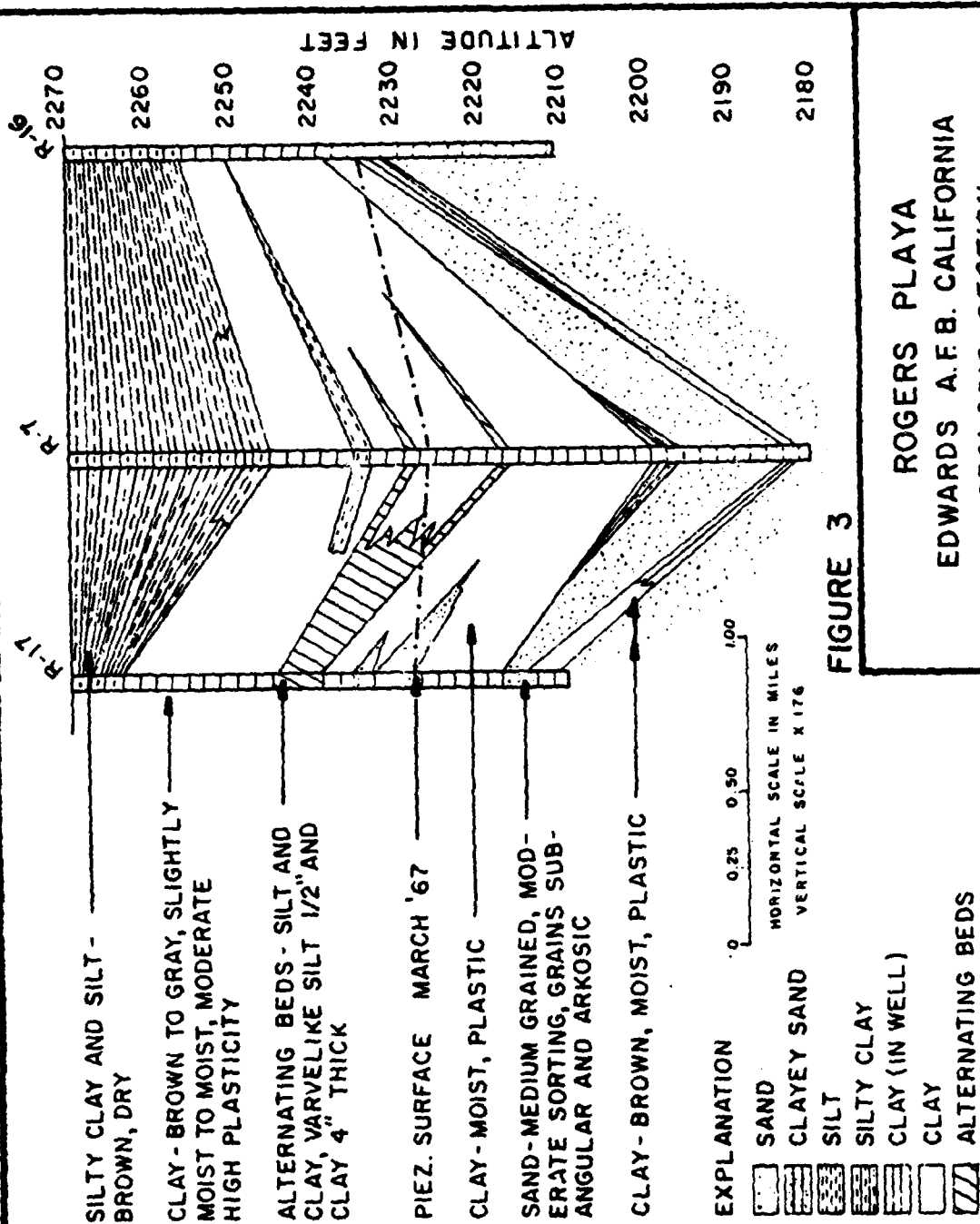
LAKESHORE DEPOSITS (Qls)

This unit is not extensive within the Edwards AFB area, but crops out in scattered locations along the periphery of the dry lake beds (northwestern rim of Rogers Lake and just south and west of Rosamond Lake; see Figure 2). It typically consists of well sorted gravel and sand with some silt and clay. The unit was deposited as beach or near-shore sediments, sorted by wave action. This unit lies above the water table, although it is very permeable (Willets et al., 1964).

Playa Deposits (Qp)

The surfaces of the three dry lake beds at Edwards AFB (Rogers Lake, Buckhorn Lake, and Rosamond Lake) consist primarily of playa deposits. The lakes also contain small scattered outcrops of other geologic units described in this report (see Figure 2).

The playa deposits were formed by the accumulation of sediments washed into the lower portions of the basins during floods. The thickness of these deposits ranges from a few feet to as much as 100 feet (see Figure 3). The playa deposits



typically overlie deposits of Tertiary and Quaternary age unconformably, and they interfinger laterally with alluvial debris of late Pleistocene and Recent age (Willets et al., 1964).

Fine sands, silts, and clays compose the playa deposits except along the periphery of the lakes where alluvium interfingers with playa sediments. Blue or green Pleistocene lacustrine deposits often underlie the buff or brown surface deposits (Willets, et al., 1964). Figure 3 shows a representative geologic section across part of Rogers Playa (Motts and Carpenter, 1966). Soils on the lake beds are alkaline, which inhibits plant growth. These alkaline soils are derived from the physical and chemical weathering of the igneous and metamorphic rock in the area. The clays of Rogers Lake are composed of approximately 45 percent montmorillonite, an aluminum-magnesium silicate; 50 percent illite, which is chemically similar to montmorillonite but has different physical properties; the remaining 5 percent is composed of chlorite, a magnesium silicate, and kaolinite, an aluminum silicate. The clays of Rosamond Lake are composed of approximately 25 percent montmorillonite, 50 percent illite, and 25 percent chlorite (Droste, 1961). According to Dana (Dana, 1966), montmorillonite absorbs water and is, therefore, an expandable clay. The opposite is also true, i.e., when the clay is wet and heat (desert sun) is applied, the water

evaporates and the clay shrinks. This helps to account for the desiccation cracks occurring on playa surfaces. The spacing between the cracks is generally 3 to 6 inches around the edges of the lake. However, in some portions of the interior of Rogers Lake, the general spacing remains the same as at the edge but giant fissures have developed at greater intervals. The giant desiccation fissures are reported to initiate below the surface. The smaller cracks are the result of surficial drying and occur throughout the lake bed. Some giant fissures are as deep as 5 meters (Theodosis, 1969).

During the wet season, generally from November through April, standing water in the lakes can range from a few inches to 2 feet deep. The water may remain in the lakes until as late as May or July before evaporating. The playas receive all of the precipitation runoff from the surrounding areas, as far away as the San Gabriel Mountains (see Figure 4, in pocket). There is no surface drainage from the lake beds to other drainage systems.

The fine-grained playa deposits generally have a low permeability and, even when they are saturated, yield very small quantities of water to wells. Braun, et al. (1975), reported that the Rogers Lake clays have a coefficient of permeability which ranges from 1×10^{-4} cm/sec to 1×10^{-8} cm/sec.

These figures are based on laboratory tests run on samples and in-situ falling head tests. Where they act as confining beds, playa deposits often cause artesian conditions in the underlying sediments (Willets, et al., 1964).

Pre-Tertiary Basement Complex, Undifferentiated (pTu)

Most bedrock outcrops within Edwards AFB belong to this unit (Figure 2). The uplands in the northwest and eastern portions of the base that are not covered by alluvial or aeolian deposits typically consist of thin residual soils overlying pre-Tertiary bedrock. The residual soils range from zero to more than five feet in thickness and contain widely varying amounts of clay (Hughes, 1975).

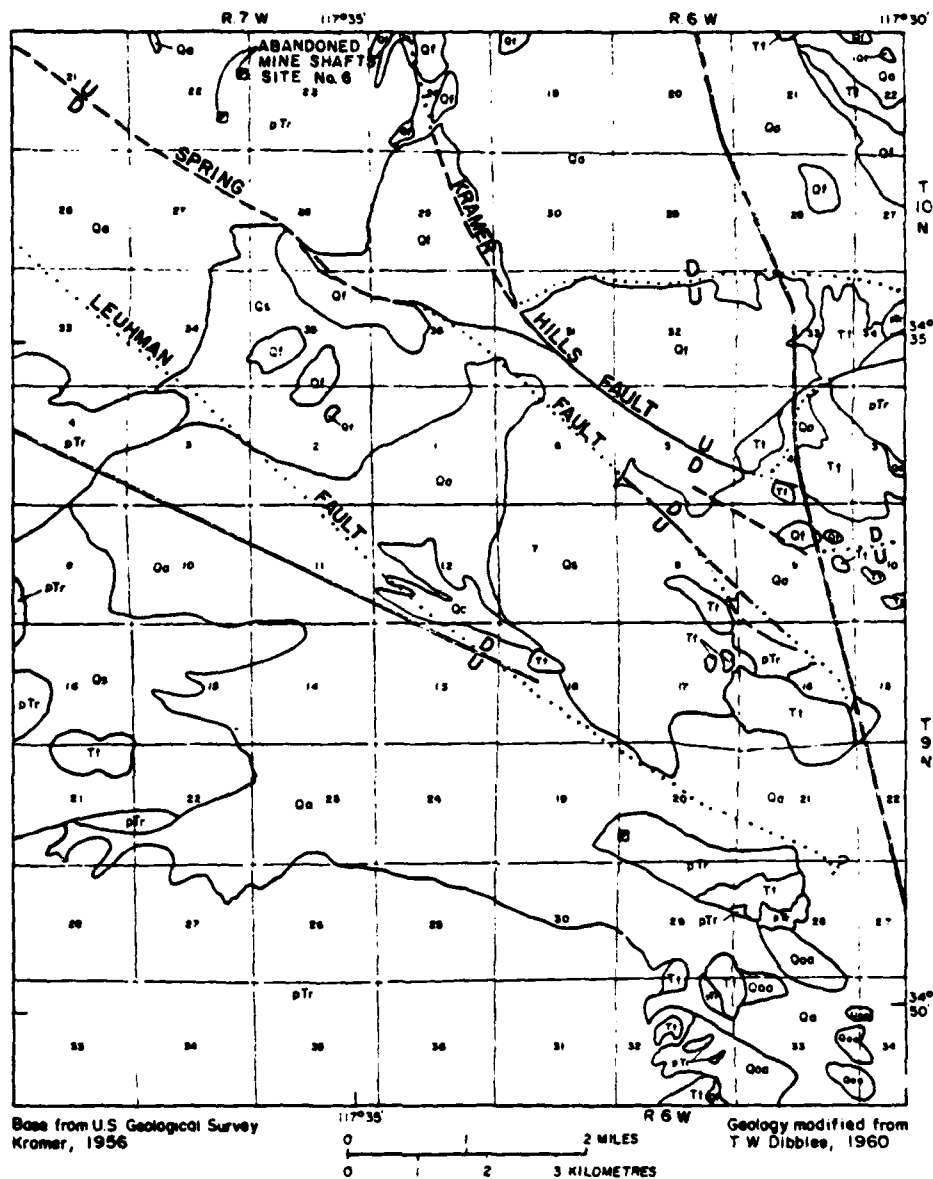
The bedrock itself consists primarily of quartz monzonite, with some granite, gneiss, schist, metavolcanics and pegmatite dikes (Willets et al., 1964). Where the bedrock is fractured or deeply weathered, this unit may yield small amounts of water to wells.

FAULTING IN THE MOJAVE BLOCK

The Mojave Block is a term applied by Hewett in 1954 to the part of the Mojave Desert that lies between the San Andreas fault on the southwest and Garlock fault on the north. Structural features on each side of this block have little similarity to those within the block. It is believed that the Mojave Block

was involved in the Jurassic and Cretaceous orogenies, and that by middle Miocene time, when the first Tertiary deposits were laid down, this block had been uplifted as much as 20,000 feet in relation to the areas to the north and south of it. (Willems, et al., 1964).

Faulting has divided the Mojave Block into two systems: a northwesterly trending group of faults which are subparallel to the San Andreas fault and a system of faults in the northeastern portion of the Mojave Block which has no dominant direction. Most of the faults which parallel the San Andreas fault generally range in length from 3 miles to 20 miles, with some faults as long as 40 miles. Reverse, normal, and scissor faults have been observed in the field. Recent movement is shown by scarps and sag ponds, and abrupt water level variations have been used to determine the location of faults buried by the Recent Alluvium (Willems, et al., 1964). Some fault traces are shown in Figures 4 and 5.



EXPLANATION

HOLO- CENE	Qa	Qc	Qs	QUATERNARY
	ALLUVIAL SAND AND GRAVEL	PLAYA CLAY	WINDBLOWN SAND	
PLEISTO- CENE	Qoo	Qf		TERTIARY
	OLDER ALLUVIUM	ANGLOMERATE		
	Tt			PRE-TERTIARY
	TROPICO GROUP INCLUDES SANDSTONE, CLAY SHALE, LIMESTONE AND (OR) DOLOMITE, CALICHE, SHALE, RHYOLITE, ANDESITE, DACITE, TUFF, AND CLIVINE BASALT			
	pt			PRE-TERTIARY
	PRE-TERTIARY ROCKS CONSISTING MOSTLY OF QUARTZ MONZONITE ALSO INCLUDES GRANITE AND DIKE (INTRUSIVE) ROCKS			

CONTACT

$\frac{U}{D}$ --- ?
FAULT

DASHED WHERE APPROXIMATELY LOCATED
DOTTED WHERE CONCEALED, QUERIED
WHERE DOUBTFUL, U UPTHROWN SIDE,
D, DOWNTOWN SIDE

■
MINE SHAFT



FIGURE 5
SITE LOCATION DRAWING
OF ABANDONED MINE SHAFTS
SHOWING GEOLOGY AND FAULTS
From Hughes, 1975

CHAPTER 3

CLIMATE

Edwards AFB has an arid desert climate. In the six winter months (November through April), the average low temperature is 36°F (2°C) and the average high temperature is 63°F (17°C). During the six summer months these averages are 57°F (14°C) and 89°F (32°C) respectively. The annual average high temperature is 76°F (24°C). The annual average low is 46°F (8°C). The average daily temperature is 61°F (16°C). The extremes for the years 1943 to 1979 are 3°F (-16°C) and 113°F (45°C) (See Table 2).

The amount of precipitation is extremely variable. It ranges from 11.07 inches (in 1979) to 0.85 inches (in 1953). The average annual precipitation is 4.34 inches. The number of days with precipitation is extremely low. The average (as of 1979) is 9.4 days per year with precipitation.

Six out of the last eight years have had higher than average precipitation. This implies that there has been more water available for recharge to the groundwater systems. Some precipitation each year is in the form of snow.

TABLE 2

LOCATION -- 34°54'N 117°52'W
ELEVATION -- 2312 FEET

	WINTER						SUMMER						ANNUAL	
	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT		
TEMPERATURE	MEAN TEMP (°F)	52	44	44	48	52	58	66	74	82	80	74	62	61
	MEAN DAILY MAX (°F)	67	57	57	61	65	73	80	89	99	97	92	79	76
	MEAN DAILY MIN (°F)	36	30	30	34	38	44	51	58	66	64	57	46	46
	EXTREME MAX (°F)	85	84	82	80	87	97	105	112	113	112	109	99	113
	EXTREME MIN (°F)	13	7	3	14	17	27	32	40	51	47	34	19	3
	MEAN DAYS > 100°F	0	0	0	0	0	0	.3	5	15	12	4	0	36
	MEAN DAYS < 32°F	10	21	20	12	6	1	0	0	0	0	0	1	71
	MEAN REL. HUMIDITY (%)	51	57	53	50	46	45	39	35	28	30	34	37	42
PRECIPI- TATION	MEAN PRECIP. (INCHES)	.63	.71	.66	.74	.45	.26	.04	.02	.04	.10	.14	.15	4.34
	MEAN DAYS W/PRECIP	1.1	1.3	2.4	1.2	1.3	.9	.02	0	0	.2	.2	.6	9.4
	MEAN SNOWFALL (IN.)	.2	.2	.6	T	.1	0	0	0	0	0	0	0	1.1
	EXTREME MAX PRECIP.	3.35	3.7	5.55	4.4	2.68	1.49	.72	.31	.4	1.01	1.38	1.65	11.07
FLYING WEATHER (Ceiling)	5,000'; VSBY-5 MI (%)	3.6	5.4	8.5	5.4	5.2	4.1	1.3	.4	.2	.1	.4	1.3	3
	1,500'; VSBY-3 MI (%)	1	1	1	1	1	.5	.5	.5	.5	.5	.5	.5	.5
	200'; VSBY-1/2 MI (%)	.5	.5	.5	.5	.5	.5	.5	0	0	.5	.5	.5	.5

T = TRACE

The snow that falls onto the lakebeds and surrounding areas tends to melt after a few hours. However, the snow that falls on the buttes and in the mountains remains for longer periods. See Table 2 for Summarized Climatological Data for Edwards AFB.

CHAPTER 4

HYDROLOGY

SURFACE WATER HYDROLOGY

EEI has identified portions of four major watersheds in Edwards AFB, based on the area's topography: Rogers Lake, Rosamond Lake, Harper Lake and Buckthorn Canyon (see Figure 4, in pocket).

Rosamond and Rogers lakes are the ultimate receiving bodies for runoff within their respective watersheds. These dry lakes are located within the base and, as shown in Figure 4, they collect runoff from large areas outside of the base as well as most of the runoff originating on the base. Only a small portion of the eastern part of the base drains off-site to Buckthorn Canyon or Harper Lake.

Some portions of the area shown in Figure 4 have very poorly defined surface drainage. This is especially true of the low, flat area north of Leuhman Ridge, where runoff from the ridge runs north onto this flat area and then evaporates and/or soaks into the ground. This area has been included in the Rogers Lake Watershed strictly on the basis of topography, and not because Rogers Lake actually receives runoff water from the area.

As described in the chapter on climate, Edwards AFB receives very little precipitation. However, when a rainfall does occur, there may be a flash flood because the ground, which is typically parched, is not able to absorb the rain before the water runs off. This often results in sheet runoff which is eventually channelled into the streams and arroyos. If the streams and arroyos cannot handle the sudden influx of water, a flood results.

In a conversation with the base meteorological staff, it was pointed out that the lake beds do have standing water every winter. Since the surface is very impermeable, the water remains there until it evaporates. Occasionally there will be a wind which has sufficient force to blow all the lake water to one side of the lake while the other side is dry. If the wind changes, the location of the water will shift accordingly. This process serves to smooth out any small surface irregularities which may have been present (Theodosius, 1969).

GROUNDWATER HYDROLOGY

Groundwater Occurrence

One main water-bearing aquifer is known to underlie the Rogers and Rosamond Lake playas and is located within the older alluvium (Qoa). Saturated sand and silty sand lenses are known to exist in the shallower, younger alluvial deposits, but are

generally not considered a reliable source of water (Braun, Skaggs, Kevorkian and Simons, 1975).

Portions of most of the other geologic units will sometimes yield water to wells, but the yields are low and the aquifers⁽¹⁾ are not very extensive laterally. These minor aquifers, where they occur in the older and younger dune sand deposits, are typically perched on top of more fine grained deposits such as the Playa Deposits (Qp), and are not directly connected to the underlying main water-bearing aquifer. The more well sorted gravels and sands in the Older Fan Deposits (Qof), where saturated, might also yield a little water to wells.

The Playa Deposits (Qp) contain some lenses and zones which are more permeable than others. The permeability of these deposits has been investigated as part of several studies. One study conducted by Braun, Skaggs, Kevorkian and Simons (1975) measured the horizontal coefficient of permeability using field percolation tests. The results of these tests for the near surface playa clays averaged 5×10^{-6} centimeters per second (cm/sec).

(1) As used in this report, the term aquifer refers to any portion of a saturated geologic unit that is capable of yielding water to a well at a pumpable rate (usually at least one gallon per minute).

The sandier and more permeable strata from 8 to 30 feet below the surface had a measured horizontal coefficient of permeability of 1×10^{-4} (cm/sec). Therefore, even these more permeable strata, if saturated, would not be considered aquifers.

Most of the bedrock units will yield small amounts of water only if they are deeply weathered or heavily fractured (Dutcher et al., 1962). The occurrence and movement of groundwater in the Haystack Butte area was investigated by Hughes (1975). The water table contours shown in the southeast portion of Figure 6 (in pocket) were taken from that report. Hughes concluded that most of the groundwater flow in this area was restricted to the Tertiary and Quaternary deposits, and that flow in the pre-Tertiary weathered quartz monzonite was negligible. He also stated that the unweathered quartz monzonite is essentially impermeable.

The Tertiary rocks exposed in the Haystack Butte area are mostly made up of the Tropico Group. This group was described by Dibblee (1960) as a sequence of lacustrine, fluvial, and volcanic strata composed mostly of sandstone, clay shale, limestone, dolomite, shale, tuff and basalt (See Figure 5). The permeability of the Tropico Group is in part a function of the individual rock type and can be very low in shale or moderately high in sandstone, basalt, and calcareous rock. Permeability

tests conducted in the basalt showed a horizontal coefficient of permeability ranging from 2.5×10^{-6} to 9×10^{-8} cm/sec (Hughes, 1975). Table 4 is a summary of the waterbearing characteristics of the various geologic units occurring at Edwards Air Force Base.

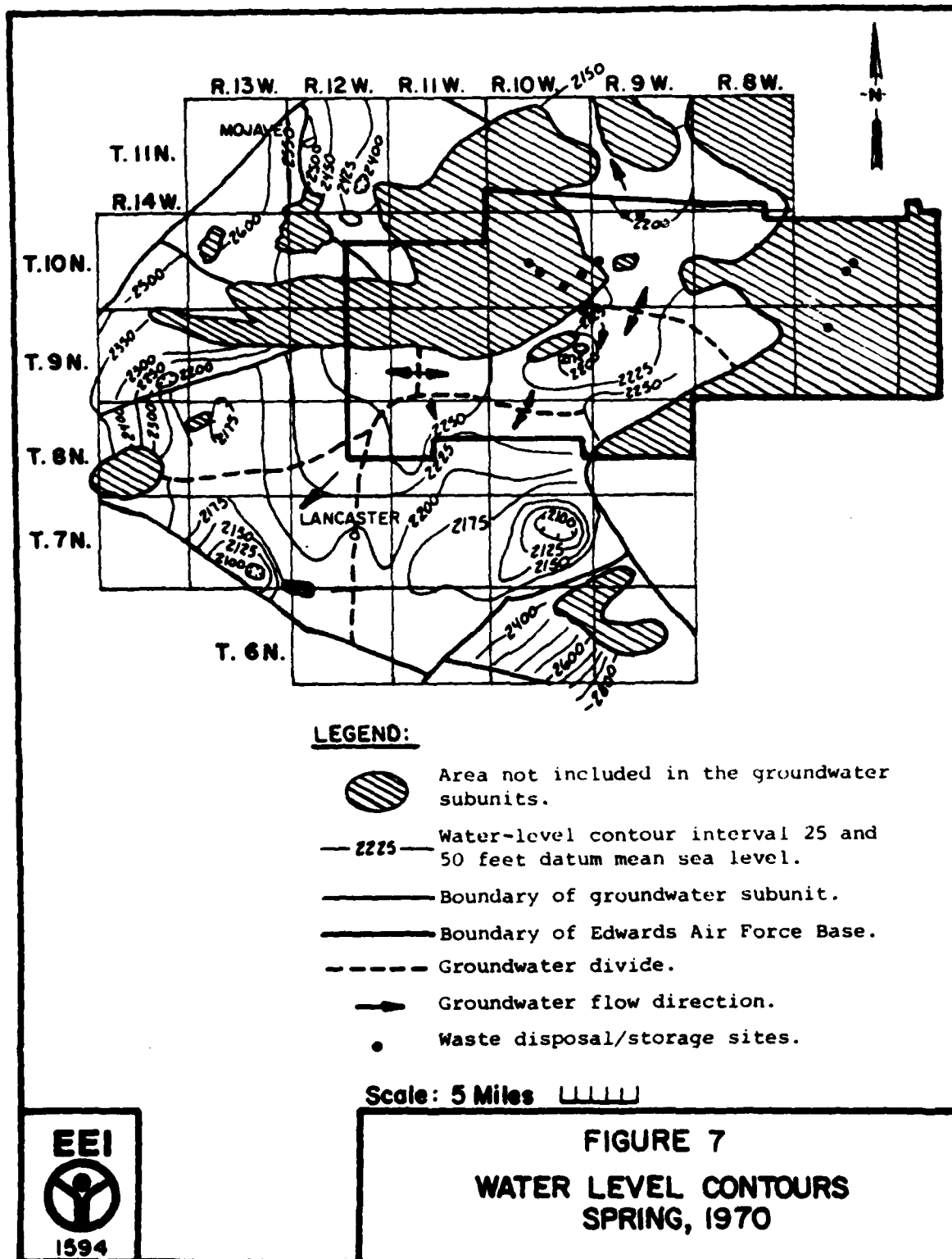
Groundwater Movement, Recharge and Discharge

Figure 6 (in pocket) also illustrates the groundwater level contours for March 1963 in the rest of the Edwards AFB area. This figure shows a large, well defined cone of depression centered just south of Edwards AFB, and a smaller, shallower cone of depression near the southern end of Rogers Lake. Figure 7 shows the groundwater level contours in spring of 1970. A comparison of these two figures reveals that the cone of depression to the south of the base had intensified and shifted slightly to the southeast by 1970, and that the cone of depression on base remained stationary, but deepened somewhat.

Both of these cones are caused by groundwater withdrawal through wells. The cone on base is caused by pumping from the Main Base well field (Geissman and Robson, 1965); the cone south of the base appears to be formed from agricultural and municipal withdrawals (this assumption is based on apparent land uses). Figure 7 illustrates the capture areas (groundwater divides) for the cones of depression and the generalized direction of groundwater flow at Edwards AFB and vicinity.

TABLE 4
SUMMARY OF WATERBEARING CHARACTERISTICS

Qoa	Older Alluvium	Main Aquifer - some highly permeable zones
Qya	Younger Alluvium	Contains some permeable zones; may be above the water table; not considered a reliable source of water
Qds, Qos	Dune Sand	Permeable; where saturated, typically perched
Qof	Older Fan Deposits	May yield water to wells where saturated; not a reliable source of water
Qp	Playa Deposits	Measured Coefficients of Permeability: Vertical: 1×10^{-7} cm/sec Horizontal: 5×10^{-6} cm/sec- near surface 1×10^{-4} cm/sec- 8-30 feet below surface
Tt	Tropico Group	Measured Coefficient of Permeability: Basalt Horizontal: 2.5×10^{-6} cm/sec to 9×10^{-8} cm/sec
pTu	Pre-Tertiary Bedrock	Unweathered Quartz Monzonite: Impermeable Weathered Quartz Monzonite: Groundwater flow is negligible



As shown in Figure 7, groundwater in the main aquifer north of the boundary between T.9N and T.10N. (approximately the old South Base area) flows to the north.

Most of the groundwater occurring in the main aquifer throughout the rest of the base flows toward and is captured by the Main Base well field (cone of depression).

In years past, the head of water confined in the main aquifer in the lower, older alluvium exceeded the level of the shallower, younger alluvial sand and silty sand deposits. When the confining clay above the main aquifer was penetrated, artesian flow into the shallower sand and silty sand deposits was quite common. In more recent years, increased pumping withdrawal from the main aquifer has lowered the head of water, in some locations below the confining bed. Apparently the withdrawal quantity from the water bearing aquifer is exceeding the replenishing supply (Braun, Skaggs, Kevorkian and Simons, 1975).

The main aquifer is currently recharged primarily along the margins of the lake basins (Willets et al., 1964). Discharge is through wells. Figure 8 illustrates this general relationship. Some of this recharge occurs through deep infiltration and subsurface lateral flow of rainwater and snowmelt which fall on alluvium surrounding the playas. Some recharge also occurs

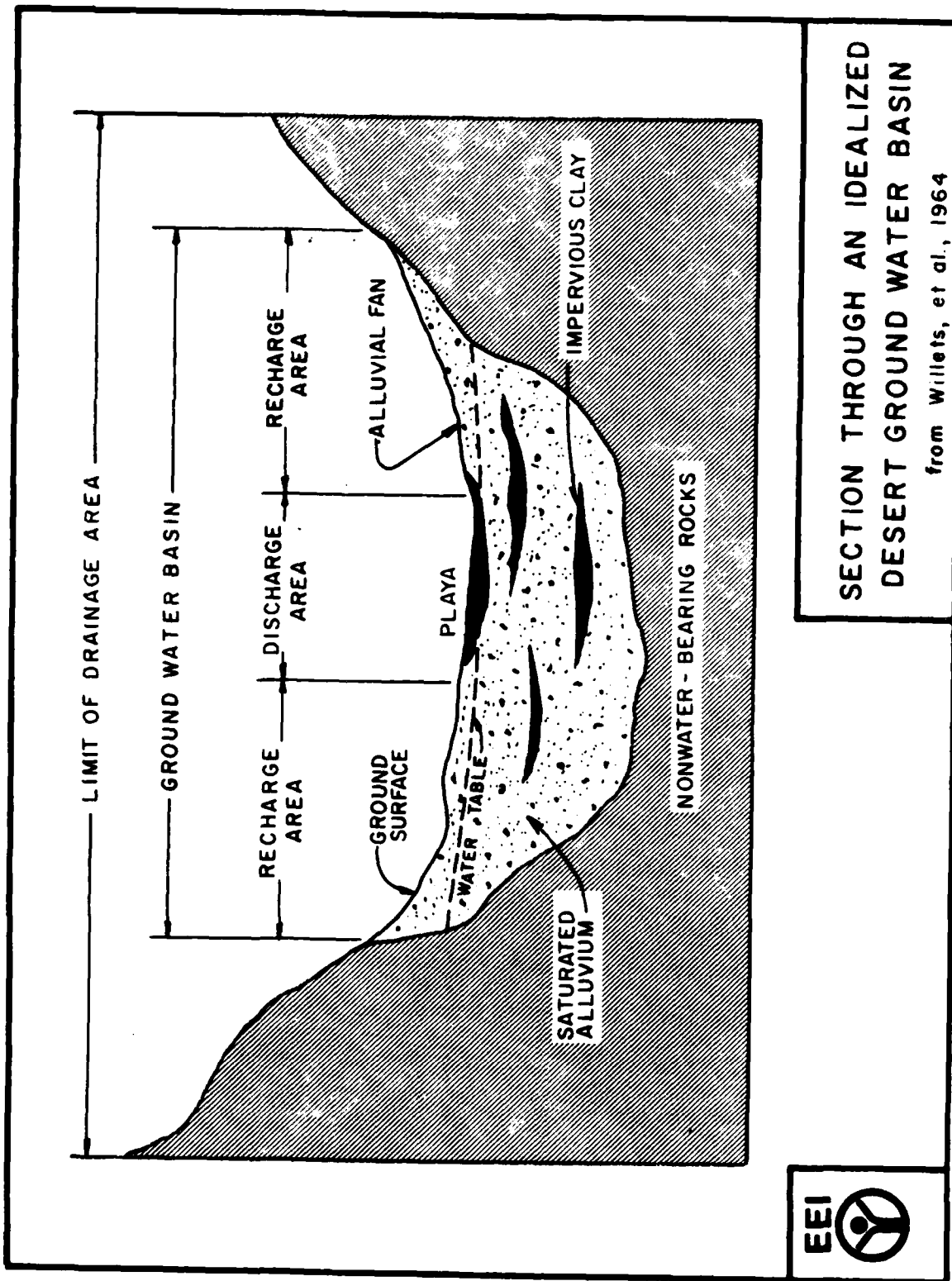


FIGURE 8

through infiltration of runoff water into the channel bottom deposits of the arroyos that drain into the playas (Willems et al., 1964). The water which ponds on the playas in the winter is also a potential source of groundwater recharge. However, based on an analysis of the studies cited in this report, EEI believes that recharge from this source is minimal. The reasoning behind this conclusion is described in the following text.

Several investigators have studied the moisture regimes, permeability and potential for recharge through the playa deposits in Rogers Lake (Motts and Carpenter, 1964; Braun, Skaggs, Kevorkian and Simons, 1975; and Theodosis, 1969). These investigators generally agree that recharge to the main aquifer through intact playa deposits is likely to be minimal at best.

Theodosis (1969) concluded that the giant dessication fissures (giant polygons) which have formed on Rogers Lake (Figure 9) may be a source of localized recharge to the underlying aquifer. Braun, et al. (1975) reported that a backhoe trench excavation across one of these fissures indicated that, though open at the surface, the predominantly sediment-filled fissure did not extend completely through the fine grained playa deposits. The presence of sediment within the fissure was to be expected since

LEGEND:

AREA OF GIANT POLYGONS FORMED PRIOR TO 1965

AREA OF GIANT POLYGONS FORMED IN 1965 AND 1966

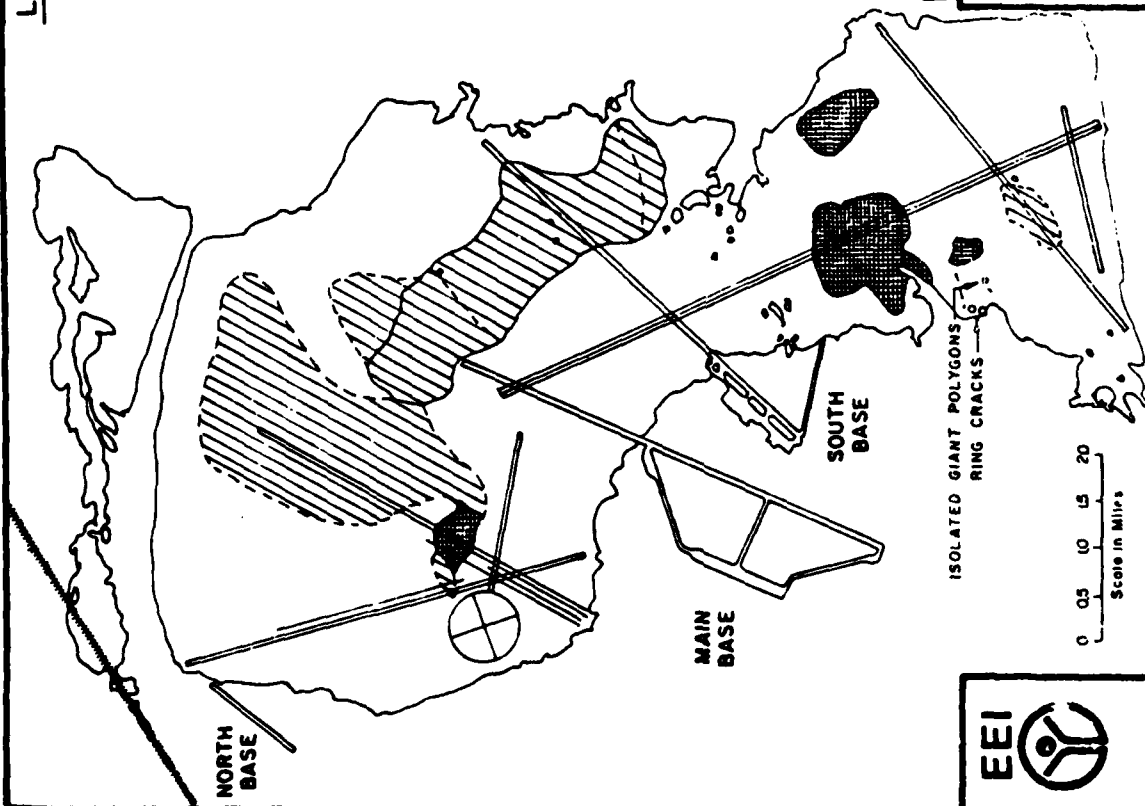


FIGURE 9

SEQUENTIAL DEVELOPMENT OF
GIANT DESICCATION POLYGONS
ROGERS PLAYA

the lake bed is covered with water every winter. Because these fissures do fill with sediment and the areal extent of the actual fissures is small compared to the area of the lake, it seems unlikely that they serve as more than a very minor route for groundwater recharge.

For those portions of the lakebeds where the playa deposits are intact, EEI believes that there is no net annual recharge from the water which ponds in the winter. This conclusion is based primarily on an interpretation of certain aspects of the Motts and Carpenter report. In their report they described a possible mechanism for the formation of the giant polygons. According to their report, these giant polygons appear suddenly (almost overnight), but actually form slowly over a period of years. The lake bed clays (Playa Deposits) are no longer in contact with the saturated sands and silts because the water table has been lowered by pumping wells. With the lowering of this potentiometric surface, the clays tend to consolidate and force the water out. Continued evaporation from the surface causes water to migrate upward through capillary action. With this drying action, the clay will tend to shrink. This shrinking starts in the deeper reaches of the clay (above the underlying potentiometric surface) and gradually works upward toward the ground surface.

If the bottom of the lakebed clays are still in contact with saturated sands, the sands act as a continuing source of water which prevents the clays from drying out. This may be why the polygons have formed in only portions of Rogers Lake. If this theory is correct, then it implies that there is a net annual loss of water from the lakebed clays through evaporation from the surface. If there was a net annual recharge from the surface, then the clays would not shrink laterally just because the potentiometric surface was lowered.

This theory is supported by Motts and Carpenter's study of soil moisture versus depth. Figure 10 illustrates this portion of their study. Examination of this figure and the corresponding soil descriptions indicates that the soil moisture contents are closely related to soil texture; where the soils become more silty and sandy (lower clay content), the moisture content decreases. This explains the abrupt fluctuation of the moisture curves with depth on most logs. However, for soils with the same texture, moisture content definitely increases with depth, which is further evidence for net evaporation from the surface.

The implication of this mechanism is significant. If this theory is correct, then any contaminated water which ponds only during the winter where the playa deposits are intact will not leach through to the underlying aquifer.

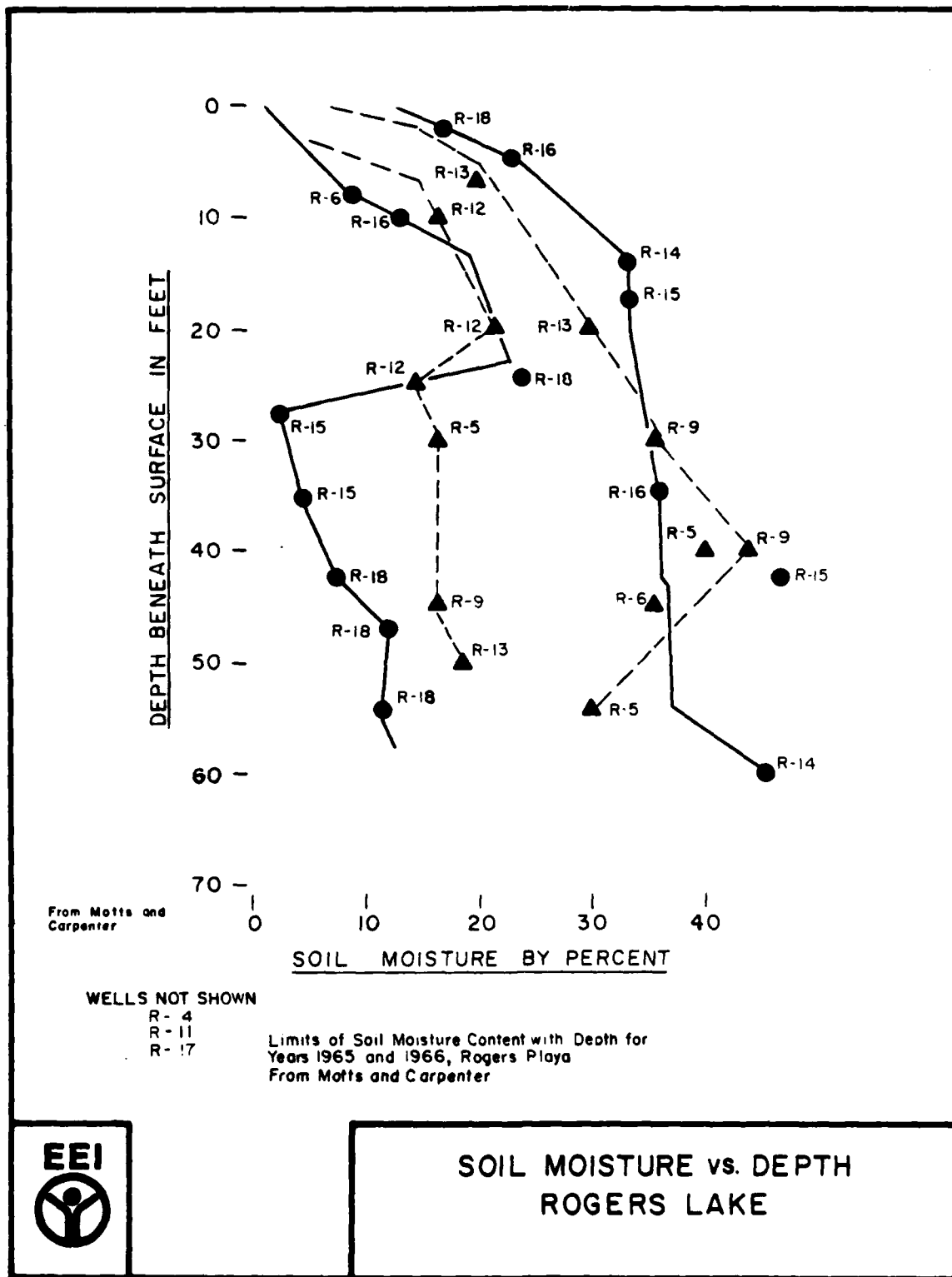


FIGURE 10

However, where ponding occurs year round, there is strong evidence that a small, net recharge through the intact playa clays can occur.

A groundwater mound was detected in the vicinity of the sanitary wastewater oxidation/evaporation ponds during a study by Braun, Skaggs, Kevorkian and Simons in 1975. The area of this groundwater mound was limited to about 600 acres. The slope of the water table at the edge of the mound was very steep. The average height of the mound was about 50 feet. If it is assumed that all of this water migrated through the lake bed clays in the bottom of the ponds, then the average vertical coefficient of permeability for those clays can be approximated in the following manner:

$$k_v = \frac{V}{A_p t i_v}$$

where:

k_v = vertical coefficient of permeability

v = volume of water contained in the groundwater mound

A_p = area of the ponds

t = time since the ponds were placed into operation

i_v = vertical hydraulic gradient

and:

$V = A_m h n$, where:

A_m = Area of the groundwater mound

h = average height of the mound

n = effective porosity of the soils within the mound

A_p = 300 acres

A_m = 600 acres

t = 35 years

h = 50 feet

n = 0.1 (estimate)

i_v = 1 (less than 2, greater than 0.1)

Combining the two equations shown above results in:

$$k_v = \frac{A_m h n}{A_p t i_v} = \frac{600 \text{ Ac} \times 50 \text{ Ft.} \times 0.1}{300 \text{ Ac} \times 35 \text{ yrs.} \times 1} = 0.3 \text{ Ft/Yr}$$

$$k_v = 0.3 \text{ Ft/Yr} = 3 \times 10^{-7} \text{ cm/sec.}$$

This value for the vertical coefficient of permeability agrees very well with the laboratory measurements conducted by Braun et al. (1975) on samples of the playa clays collected in the vicinity of the ponds, when the textural variability of the playa deposits is considered. These laboratory measurements indicated that values as low as 1.5×10^{-8} cm/sec can be expected. Therefore, although the low permeability of the playa deposits causes most of the ponded water to evaporate, when a ponded condition occurs continuously, some recharge to the underlying aquifer can occur.

CHAPTER 5
SITE DESCRIPTIONS AND EVALUATIONS

EVALUATION METHODOLOGY

Investigations were conducted at nine disposal and storage sites as follows: the North Lake Bed Disposal and Storage Site at the north end of Rogers Dry Lake; the Main Base Toxic Waste Disposal Site; the Abandoned Main Base Sanitary Landfill Site; the Active Main Base Sanitary Landfill; the South Base Waste Petroleum, Oil and Lubricants (POL) Storage Site; the Abandoned Mine Shafts and the Beryllium Contaminated Earth Pile at the Rocket Propulsion Laboratory (RPL); an Industrial Waste Pond; and a Petroleum Spillage Containment Pond (see Figure 4, in pocket, for site location). Field site investigations were conducted with knowledgeable base personnel as guides. Field data sheets (Appendix A) were completed for each site. If information concerning the sites was lacking following the inspections, additional base personnel were contacted to provide the missing data.

A methodology for selecting those sites with a high potential for groundwater contamination was developed. Three factors were used to evaluate each site: 1) information generated during the geological investigations; 2) rating system score sheets (Appendix B); and 3) hydrogeological analyses of each site.

The information in Chapters 2, 3 and 4 describes the general area of Edwards AFB with regard to geology, climate, and hydrology. In this chapter, each site is summarized with particular emphasis on geological and hydrological conditions.

The rating system score sheets shown in Appendix B are based on four factors relevant to land-based disposal facilities: 1) site characteristics, 2) contamination potential, 3) waste characteristics, and 4) waste management practices. The prime purpose of assigning rating factors is to classify the field information so that it can easily be interpreted.

Each of the rating factors has a three-level hazard potential scale ranging from 1 (low) to 3 (high). These scales have been developed so that the factors can readily be evaluated using the information generated under this contract. Numerical values from 1 to 3 are used only in this report. References consulted to assign hazard potentials for waste characteristics include:

Hazardous Properties of Industrial Materials by N.I. Sax
National Fire Protection Association's Guide on Hazardous Materials
CRC Handbook of Chemistry and Physics
Merck Index

The rating factors are not equally important. Therefore, a weighting factor of from one to five has been assigned to each rating factor in accordance with what EEI believes to be its relative importance. These values are multiplied by the appropriate ratings factor, resulting in the final rating factor score. The sum of these scores for each main category appears as the subtotal. The sum of the subtotals appears as the total score along with the percentage overall score (see Appendix B for Rating Forms). These scores are summarized in Table 3.

The score sheets are not intended to provide a definitive ranking of the sites. Certain types of information about several of the sites were not available, such as the permeability of the soils or the depth to the water table. Where uncertainty or lack of information was identified a worst case condition was assumed. Therefore, if additional or more detailed information is uncovered, the ranking of a particular site could change substantially. Because of this, the ranking and scores should be used as a screening tool only.

A hydrogeological analysis of each site requires pertinent hydrological and geological information and a thorough knowledge of all possible migration mechanisms in order to identify the movement of a pollutant. Even when all other aspects are present, the potential for groundwater contamination does not exist unless a migration mechanism is present. Therefore,

TABLE 3
SUMMARY OF RATING SCORES*

Site	Overall Score	Site Evaluation	Potential for Contamination	Waste Characteristics	Waste Management Practices
Site 1: North Lake Bed Disposal and Storage Site					
West Subsite: 1A	65	65	81	59	55
Drum Storage: 1B	57	65	37	69	52
Acid Pits: 1C	68	65	74	64	74
Drum Trenches: 1D	78	77	85	69	85
Site 2: Main Base Toxic Waste Disposal Site	83	46	78	100	100
Site 3: Abandoned Main Base Sanitary Landfill Site	71	54	53	88	83
Site 4: Active Main Base Sanitary Landfill	50	33	52	65	38
Site 5: South Base Waste POL Storage Site	67	67	81	58	64
Site 6: Abandoned Mine Shafts	66	40	43	90	79
Site 7: Beryllium Contami- nated Earth Pile (RPL)	55	52	43	65	55
Site 8: Industrial Waste Pond	48	33	59	49	48
Site 9: Petroleum Spillage Containment Pond	55	54	48	60	55

*Scores are shown as a percentage of the maximum.

special features concerning a site's hydrogeological setting may ultimately govern whether it constitutes a significant threat to groundwater or surface water quality. A description of each site is included in this section, followed by a discussion of the rating and an evaluation of the potential of that site to contaminate groundwater or surface water.

SITE DESCRIPTIONS

North Lake Bed Disposal and Storage Site: Site 1

Site Location - NW 1/4, NE 1/4, Sec. 4, T11N, R39E

Inspection of the North Lake Bed site indicated that four methods (subsites) of storage and disposal were practiced at this site (Figures 11 and 12).

Subsite 1A - Subsite 1A is situated in a low lying area slightly west of the other three subsites. This area is part of an abandoned roadbed.

Subsite 1A is a storage site consisting of thirteen 55-gallon drums. These drums are in fairly good condition, but signs of chemical spillage are indicated by an area devoid of vegetation. Barrel labels identify the contents of the drums as motor oil, drycleaning solvent, lube oil, and other cleaning solvents. This subsite was first recognized sometime in 1978, and a directive was issued at that time that it no longer be used.

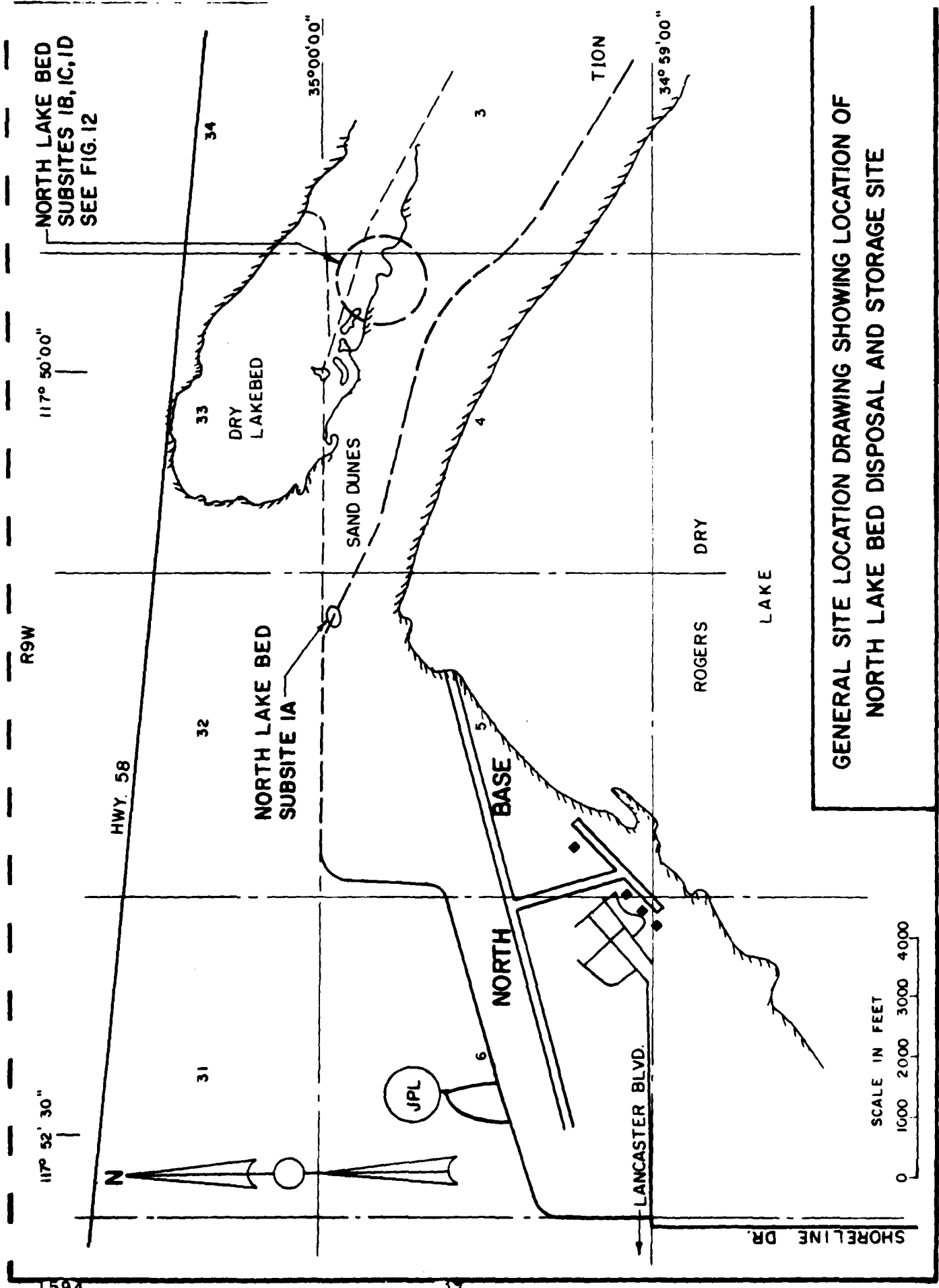
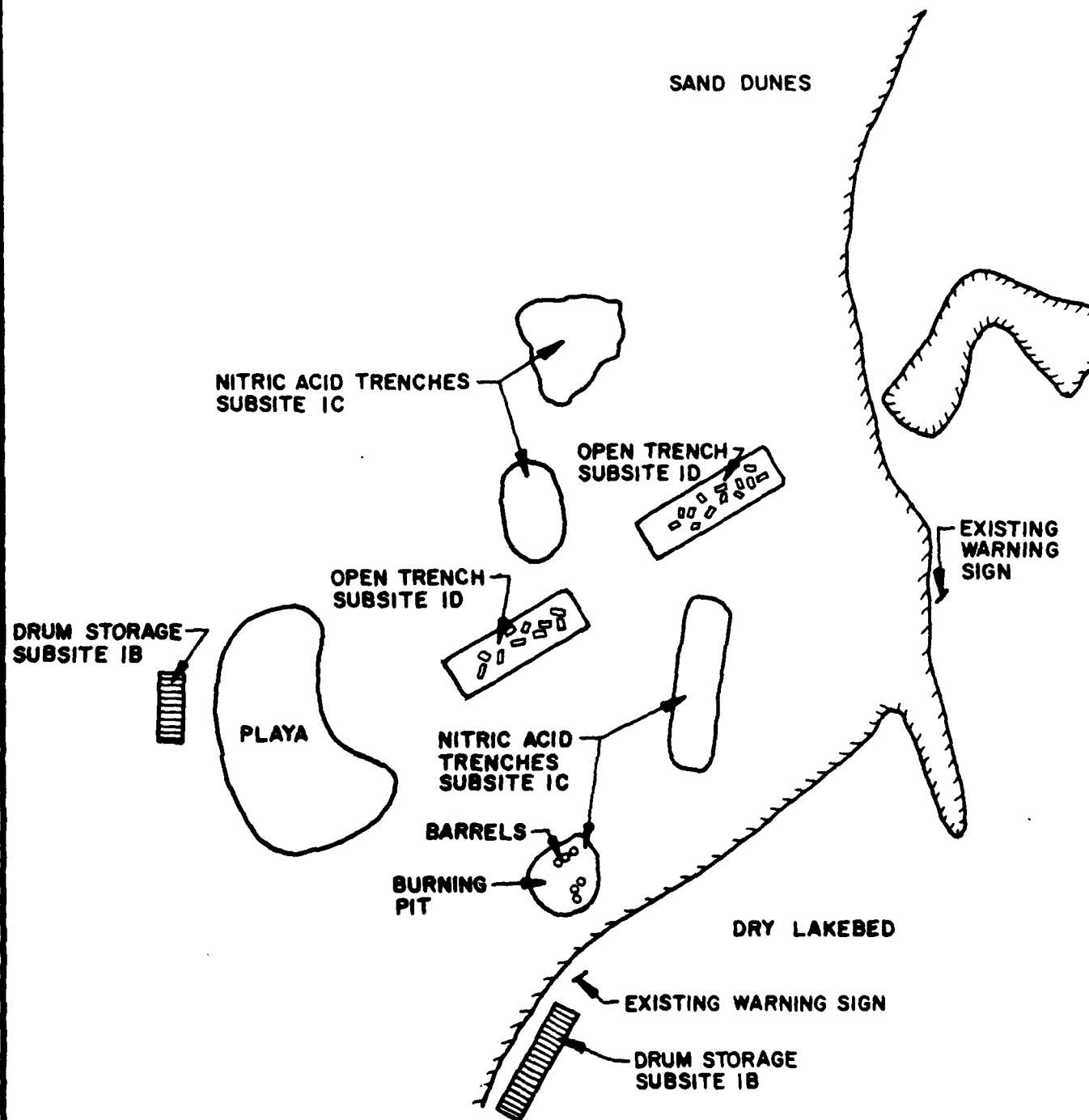
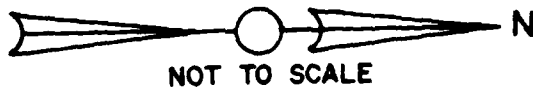


FIGURE 11



**SPECIFIC SITE LOCATION DRAWING OF
NORTH LAKE BED DISPOSAL AND STORAGE SITE**

Because the subsite is in a low lying area, the barrels are obscured from the view of travellers on the nearby roadway or on Highway 58 (one-third mile north of this subsite).

This subsite is located in a geologic unit described by Dibblee (1960) as a lakeshore deposit (see Figure 2). The log of a well (or soil boring) (USGS-4), located within 1,000 feet of this subsite and shown to be in the same geologic unit, is included in Motts and Carpenter (1966). The log shows a continuous sand unit from the surface to the underlying alluvial aquifer.

Rating and Evaluation: The overall rating score is 65 percent; however, in the category for contamination potential, this subsite is rated at 81 percent. The overall score is low because the total quantity is low and the method of storage is fairly good. The major area of concern is the geology of the site.

The log of USGS Well 4 indicates that the surface sand extends all the way down to the underlying alluvial aquifer. The migration mechanisms include leaching and direct percolation. The site is in a depression and, therefore, is subject to greater than average recharge rates. With deep sands to groundwater, the likelihood of migration to the water table is high. If the total waste quantity is 5×10^4 gallons

(plus or minus a factor of 10), the amount of water required for dilution to an acceptable range of 10 parts per billion (ppb) is 5×10^{11} billion gallons. Fifty billion gallons is a significant amount of groundwater contamination. This subsite has a high potential for serious groundwater contamination. Figure 13 illustrates a conceptual representation of this mechanism.

Subsites 1B, 1C and 1D - Subsite 1B consists of two drum storage areas in the immediate vicinity of Rogers Dry Lake. The first area consists of approximately 100 barrels, most of which lie on their sides. A warning sign is posted and reads as follows: "Keep Out - Danger, Poisonous Gases, No Smoking Beyond This Sign". Most of the barrels are stored on the lake bottom. The drums are rusted, but there is no sign of chemical leakage. The second barrel storage area consists of 16 drums in fairly good condition, but many of the drums are empty and signs of chemical spillage are obvious.

Subsite 1C was used for the disposal of fuming red and white nitric acids in shallow trenches and for burning waste fuels in steel containers. Four trenches were observed in this area. Soil discolorations and depressed areas devoid of vegetation are typical of these disposal areas. One large, flat, heat warped metal container remained on site.

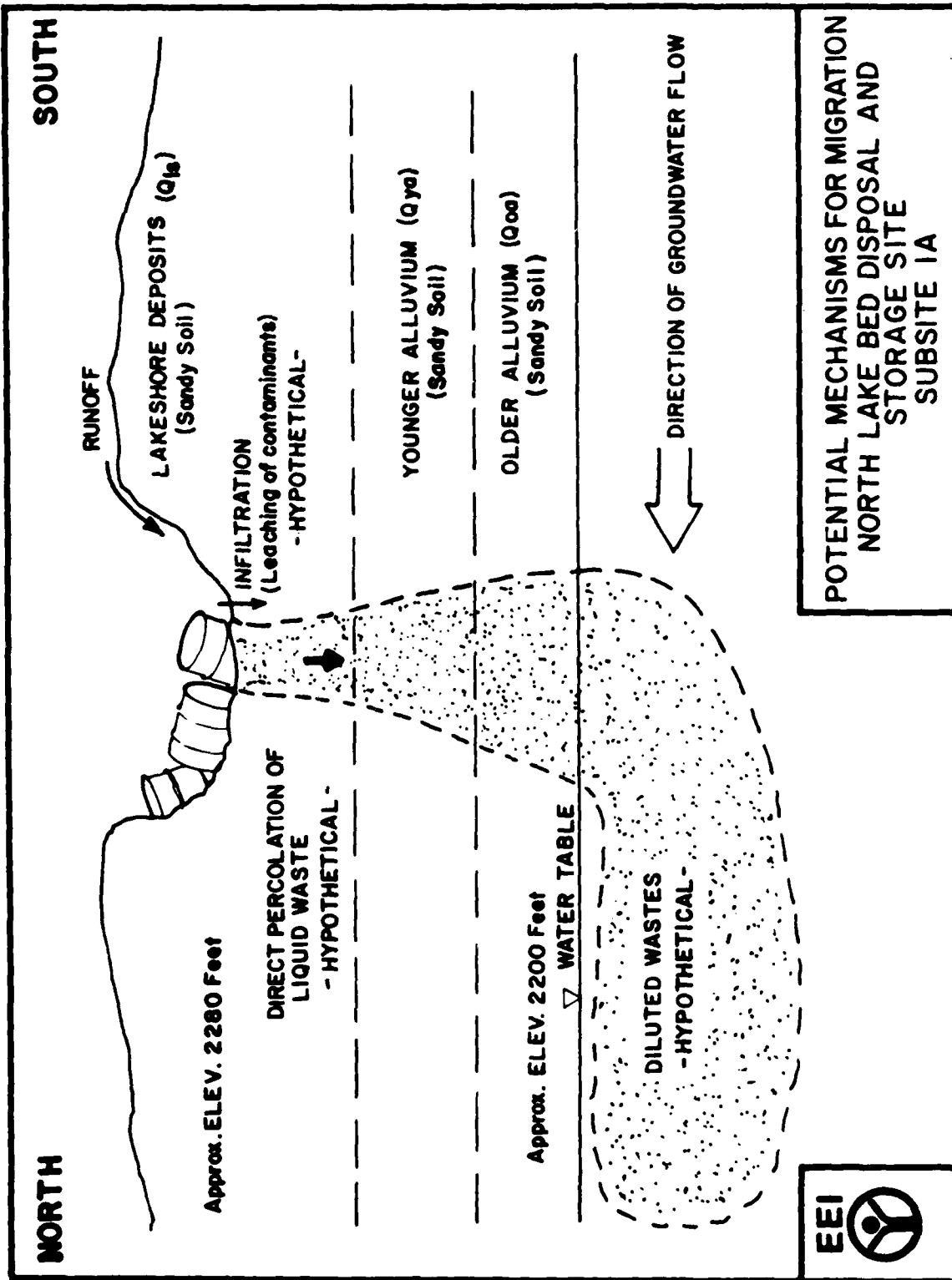


FIGURE 13

Subsite ID consists of two large barrel trenches, one site approximately 15 feet wide x 200 feet long x 10 feet deep, the other site 30 feet wide x 150 feet long x 8 feet deep. These trenches were dug with earth moving equipment and contain 55-gallon drums. The sides of the trenches have gulleys, which indicates that water washes into the trenches. Hundreds of barrels are stored at these sites and contained wastes such as aniline, furfuryl alcohol, engine cleaner, ethyl alcohol, and others. Many of the barrels are pitted and/or corroded. It is also reported that all of the barrels were emptied prior to placement in the trenches.

Subsites 1B, 1C and 1D are somewhat removed from the present, on-base roadway, but still visible from the road. These subsites are screened from view by the travellers on Highway 58 by the topography.

Figure 12 illustrates the relationship between the stabilized dune sand deposits, the lake bed clays and subsites. Based on observations of the trench walls, it appears that the dune sand in this vicinity is very thin (less than 2 feet), and is underlain by playa clays at least 10 feet thick. No giant desiccation fissures were observed in the immediate vicinity of these subsites. Dutcher, et al. (1962), and Troxel and Morton (1962) have projected the Muror Fault to a point very near these subsites. Although not specifically mentioned in the literature obtained, the outcrop patterns

and water table configuration indicate that movement along this fault was pre-Quaternary.

Rating and Evaluation:

Subsite 1B: The rating forms indicate an overall score of 57 percent while the highest subscore is 69 percent for waste characteristics. Empty drums which once contained aniline (a listed hazardous waste) are stored here and account for the high waste characteristic subscore.

Two possible mechanisms for groundwater contamination are direct percolation and surface runoff toward dessication fissures. Direct percolation does not seem very likely for two reasons: 1) most of the liquid would evaporate since the percolation rate is less than 2 inches per year (Braun), and 2) the quantity available for percolation after evaporation is small. Surface runoff into the dessication fissures is a possible mechanism. The barrels are stored on the lake bed, and there is evidence of runoff since the barrels were placed there (i.e., gullying at the edges of trenches). Evaporation of chemical leakage leaves a residue on the ground surface. This residue could be transported from the area when the lake contains water. However, the contaminants would be highly diluted, perhaps by a factor of 10^7 or more as follows:

Dilution of leakage residue by surface water:

Assume 1 "gallon" of residue left from a 55-gallon drum. The adjacent playa has a surface area of about 0.6 square miles (Dutcher). Assume runoff onto playa is 1 inch deep.

$$V = \frac{1 \text{ in} \times 0.6 \text{ mi}^2 \times 640 \text{ ac/mi}^2 \times 43,560 \text{ ft}^2 / \text{ac} \times 7.48 \text{ gal}}{12 \text{ in/ft}}$$

V = volume of water in playa = 1×10^7 gallons

1 gallon of residue would be diluted by 10^7 gallons of water in the playa.

If there were any vertical discontinuities in the clays of the playa (such as giant dessication fissures or faults), some of this dilute contaminated water might enter the underlying aquifer. However, since most of the recharge to this aquifer comes from the alluvium adjacent to the playa deposits or as underflow from the south, this slightly contaminated water would undergo even further dilution. Therefore, the potential for groundwater contamination at this subsite is very minimal.

Subsite 1C - Subsite 1C consists of four open trenches. These sites were used primarily for disposal by pouring liquid wastes into the trenches and diluting them with large quantities of water. The topsoil in these trenches shows signs of

and water table configuration indicate that movement along this fault was pre-Quaternary.

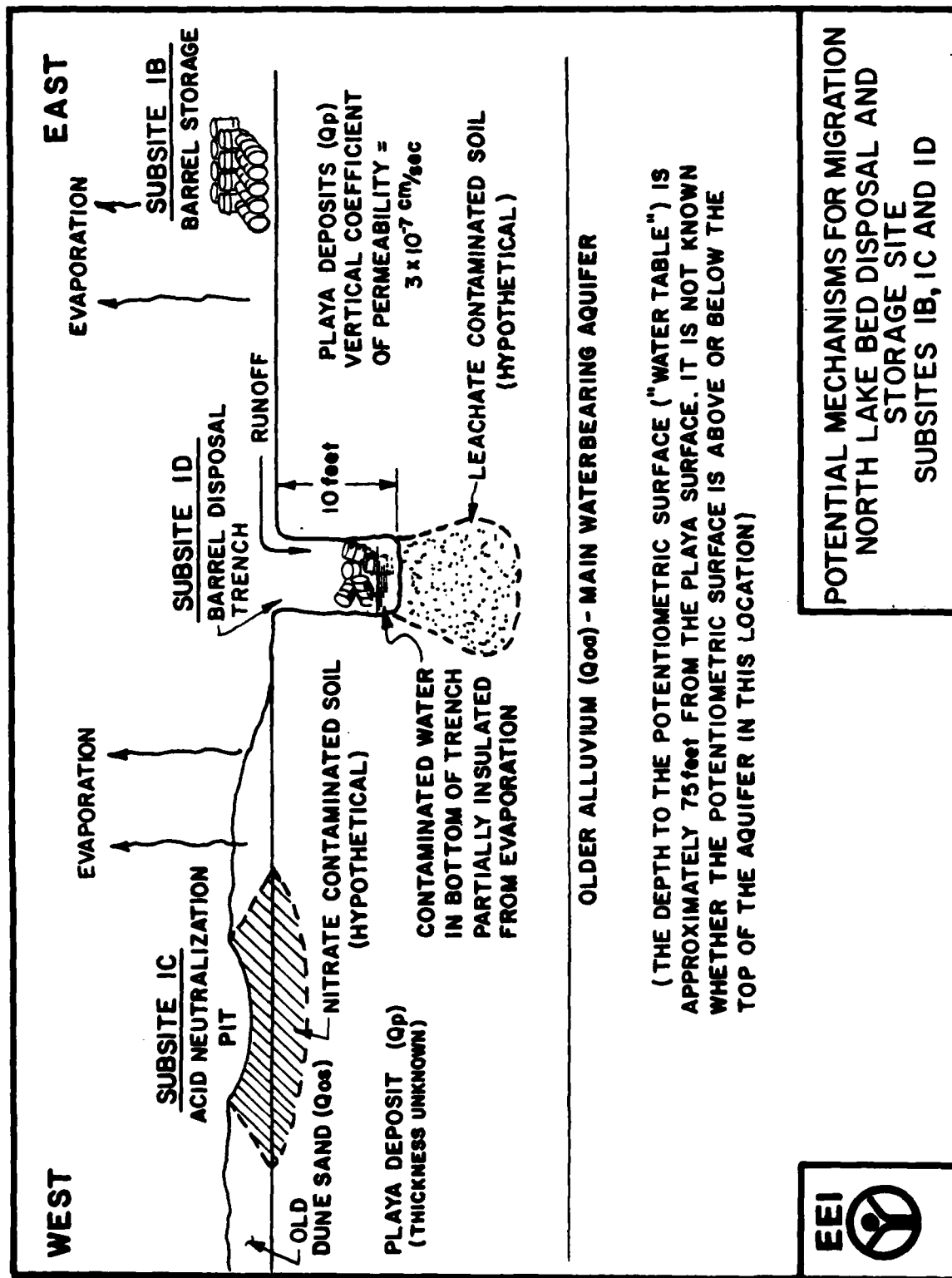
Rating and Evaluation:

Subsite 1B: The rating forms indicate an overall score of 57 percent while the highest subscore is 69 percent for waste characteristics. Empty drums which once contained aniline (a listed hazardous waste) are stored here and account for the high waste characteristic subscore.

Two possible mechanisms for groundwater contamination are direct percolation and surface runoff toward dessication fissures. Direct percolation does not seem very likely for two reasons: 1) most of the liquid would evaporate since the percolation rate is less than 2 inches per year (Braun), and 2) the quantity available for percolation after evaporation is small. Surface runoff into the dessication fissures is a possible mechanism. The barrels are stored on the lake bed, and there is evidence of runoff since the barrels were placed there (i.e., gullying at the edges of trenches). Evaporation of chemical leakage leaves a residue on the ground surface. This residue could be transported from the area when the lake contains water. However, the contaminants would be highly diluted, perhaps by a factor of 10^7 or more as follows:

chemical dumping - the soils are discolored, barren and soft. There is little or no drainage. The rating form shows an overall score of 68 percent. The high score of 74 percent was for poor management practices. Another important factor is that there is an active well within 3/4 of a mile of the site.

Wastes known to have been disposed of at this site include fuming red and white nitric acids, and waste fuels. The waste fuels are volatiles and have probably completely oxidized or evaporated. The acids would be neutralized by the calcareous soils (pH of some soil horizons might be >9) (Paul Oban Assoc.). The residue from the acids (mostly nitric) would be soluble salts such as calcium nitrate or sodium nitrate. Since the surface soils are permeable, some of these salts may have leaked into the subsoils, possibly beyond the zone of evaporation (see Figure 14). Playa clays probably underlie the sand dune deposits as evidenced by the barrel disposal trench excavations (Subsite 4). Since very little rainfall occurs at this site, percolation through the clays would be very slow. Therefore, the potential for groundwater contamination is very minimal.



POTENTIAL MECHANISMS FOR MIGRATION
NORTH LAKE BED DISPOSAL AND
STORAGE SITE
SUBSITES IB, IC AND ID

FIGURE 14

Subsite 1D - Subsite 1D consists of two large barrel trenches. The overall rating score of 78 percent is one of the highest in this study. All subscores are 69 percent or above indicating an overall need for concern. Evaluation factors of importance are: 1) active drinking water wells within 3/4 of a mile, 2) signs of empty and leaking barrels indicating chemical leakage, 3) empty drums which once contained a hazardous waste (aniline) stored with other wastes which are corrosive, and 4) poor waste management practices including storage of incompatible wastes and random placement of barrels in an excavation. It is believed that most, if not all, of the barrels in the trenches are empty.

Two mechanisms are available for contaminating groundwater from this source: direct percolation and leaching. The configuration of the trenches (deep and narrow) is such that the bottom probably has an insulating effect (see Figure 14). Water enters the trenches at infrequent intervals, as evidenced by minor gullying at the lips of the trenches. This results in a hydrologic situation which is significantly different from either the lake bed drum storage area or the acid pits. In the event of a chemical leakage, the liquid would flow to the bottom of the trench. At the bottom of the trench the evaporation rate would be lower than it would normally be at the lake bed surface. The significance of this effect is unknown and may

be slight, as most of the liquid still probably evaporates. The fact that these trenches collect runoff water is, however, significant.

The report on the sanitary wastewater oxidation/evaporation ponds (Braun) indicated that, due to the existence of year-round ponding, a perched water table or groundwater mound has developed beneath the ponds. The calculated rate of percolation (inflow - evaporation) correlates well with the measured extent and height of the groundwater mound, and this correlates fairly well with the measured vertical coefficient of permeability (1×10^{-6} cm/sec). The size of the groundwater mound indicates that the average coefficient of permeability over the 300-acre area is close to 10^{-7} cm/sec. The significance of this is clear. When water is available at the surface of the playa clays on a year-round basis, some of this water slowly migrates to the underlying aquifer. Because water occasionally collects in the drum-filled trenches, it probably remains there longer than in the other parts of the lake bed. Therefore, a net leaching effect from the bottom of the trenches to the underlying aquifer may be occurring, though very slowly. Because the trenches reportedly collect water infrequently (Yonkers 1980), this leaching mechanism (if actually occurring) is probably taking place at a much slower rate than that which is occurring in the vicinity of the oxidation/evaporation ponds. Therefore, this subsite has potential for contributing to groundwater contamination.

Main Base Toxic Waste Disposal Site: Site 2

Site Location - Central Area, Sec. 26, T10N, R38E

This site is in an area which slopes gently to the southeast toward Rogers Lake. Waste chemicals and fuels were disposed of at this site from the mid-1950's until the early 1960's (see Figure 15). The site is relatively near to the Main Base and the entire area is fenced and posted. Numerous individual sites are posted to indicate the chemicals buried there. It is not known if these signs indicate specific burial locations or if they are intended for general designation. The method of disposal is unknown, and some surface discoloration is apparent indicating chemical spillage. Vegetation and signs of wildlife are present. The size and type of vegetation indicates that the most recent soil disturbance was 15 to 20 years ago. Signs indicate buried cyanide, chromate, nitric acid, tetraethyl lead, hydrogen peroxide, and fuels.

The surficial soil at this site is loose sand and consequently has a high coefficient of permeability. The site area has been mapped (see Figure 2) as pre-Tertiary igneous rock. This indicates that the surficial sands are probably fairly thin. The thickness and presence of any underlying residuum and/or weathered bedrock is unknown. This area is not underlain by an aquifer as defined by Powers and Irwin (1971) or Geissner and Robson (1965) (see Figure 7).

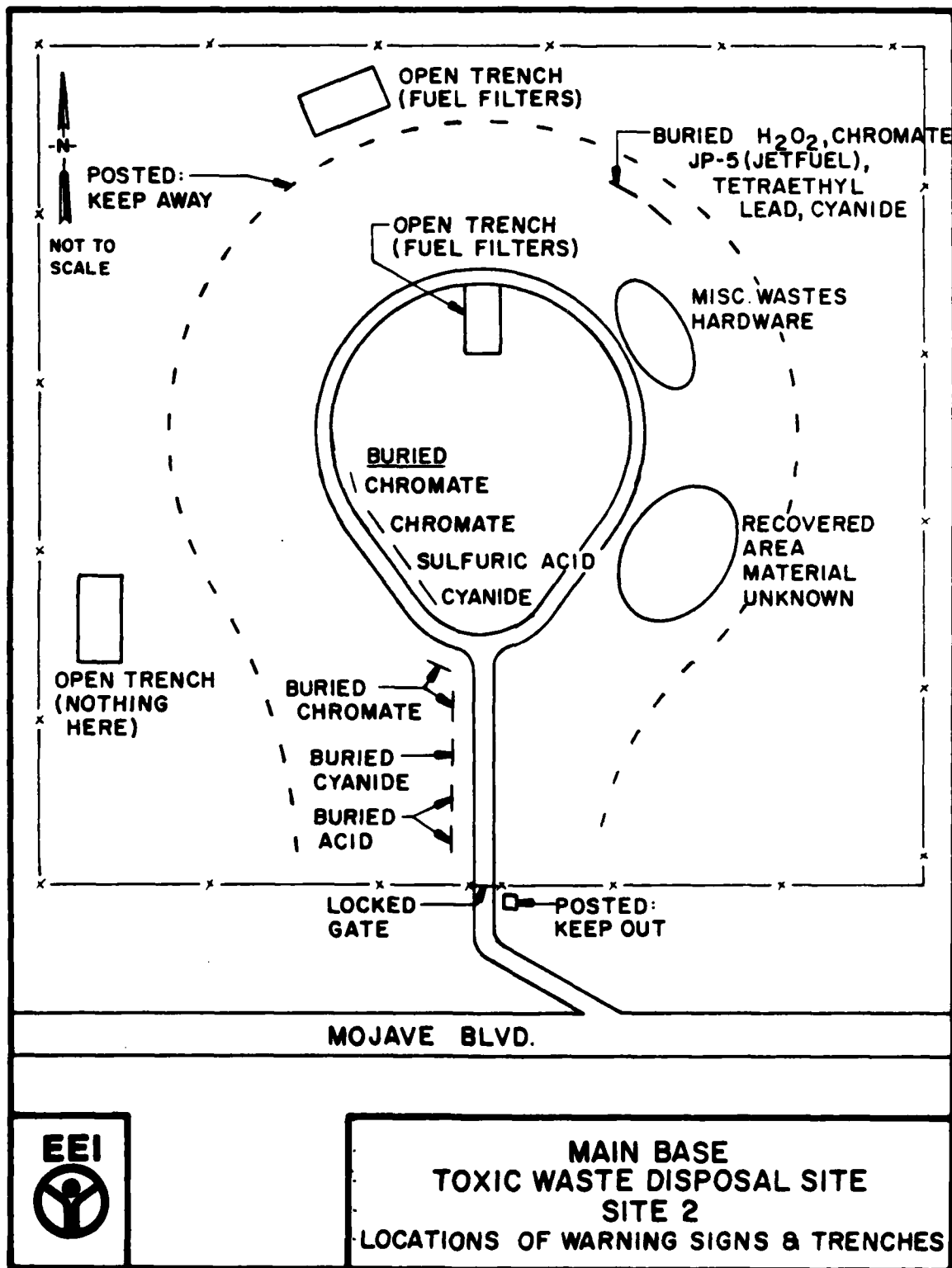


FIGURE 15

Rating and Evaluation - The Main Base Toxic Waste Disposal Site received the highest overall score of 83 percent. Subscores of 100 percent were assigned for poor waste management practices of extremely toxic and dangerous wastes such as cyanide. The potential for contamination also scored high since it is questionable whether the wastes were containerized for disposal. The integrity of the overall score of 83 percent is doubtful because there are no records concerning the site operation.

There are two possible mechanisms for the subsurface migration of contaminants - leaching and direct percolation. The geology of the area indicates that the soil is a thin layer of stabilized windblown sand over pre-tertiary bedrock. The site and the surrounding area have approximately a 2 to 3 percent slope to the southeast, with the nearest aquifer 2/3 of a mile away. This slope would encourage runoff rather than infiltration. The vegetation established on the site tends to further reduce the amount of precipitation available for deep leaching of buried solids. Considering the low rate of precipitation at the site, leaching does not appear to be a significant mechanism for contaminant migration.

Direct percolation of liquids may be of greater concern. Percolation through the surface soils would be rapid. If there is a thin layer of saturated soils overlying the bedrock,

and if they are moderately permeable soils, liquids which migrate to this layer could be transported downslope. The time required for this migration is calculated as follows:

$$t = \frac{dn}{ki}$$

Assume $n \geq 0.12$ (estimated minimum effective porosity)

i = slope of ground surface (2%)

$k \leq 1 \times 10^{-4}$ cm/sec (Braun) = 100 ft/yr

$d = 2/3$ mile = distance to the nearest aquifer

$$t = \frac{3,500' \times 0.12}{100'/\text{yr} \times 0.02} = 210 \text{ years}$$

Figure 16 illustrates this theoretical situation. The saturated layer may not exist and/or the soils may be considerably less permeable than 1×10^{-4} cm/se. Neither of these factors is known. Therefore, there seems to be a slight possibility that contaminant migration is occurring from this site. The discolored soils at this site also suggest the potential for surface water contamination. Since the site is sloped such that runoff is enhanced, the contaminants causing discoloration may be eroding downslope and eventually may enter Rogers Lake.

Abandoned Main Base Sanitary Landfill Site: Site 3

Site Location - 150 Acres; SW 1/4, SE 1/4, Sec. 21, T10N, R38E

This site was used for landfill from the middle 1950's to the middle 1970's (see Figure 17). Little is known regarding

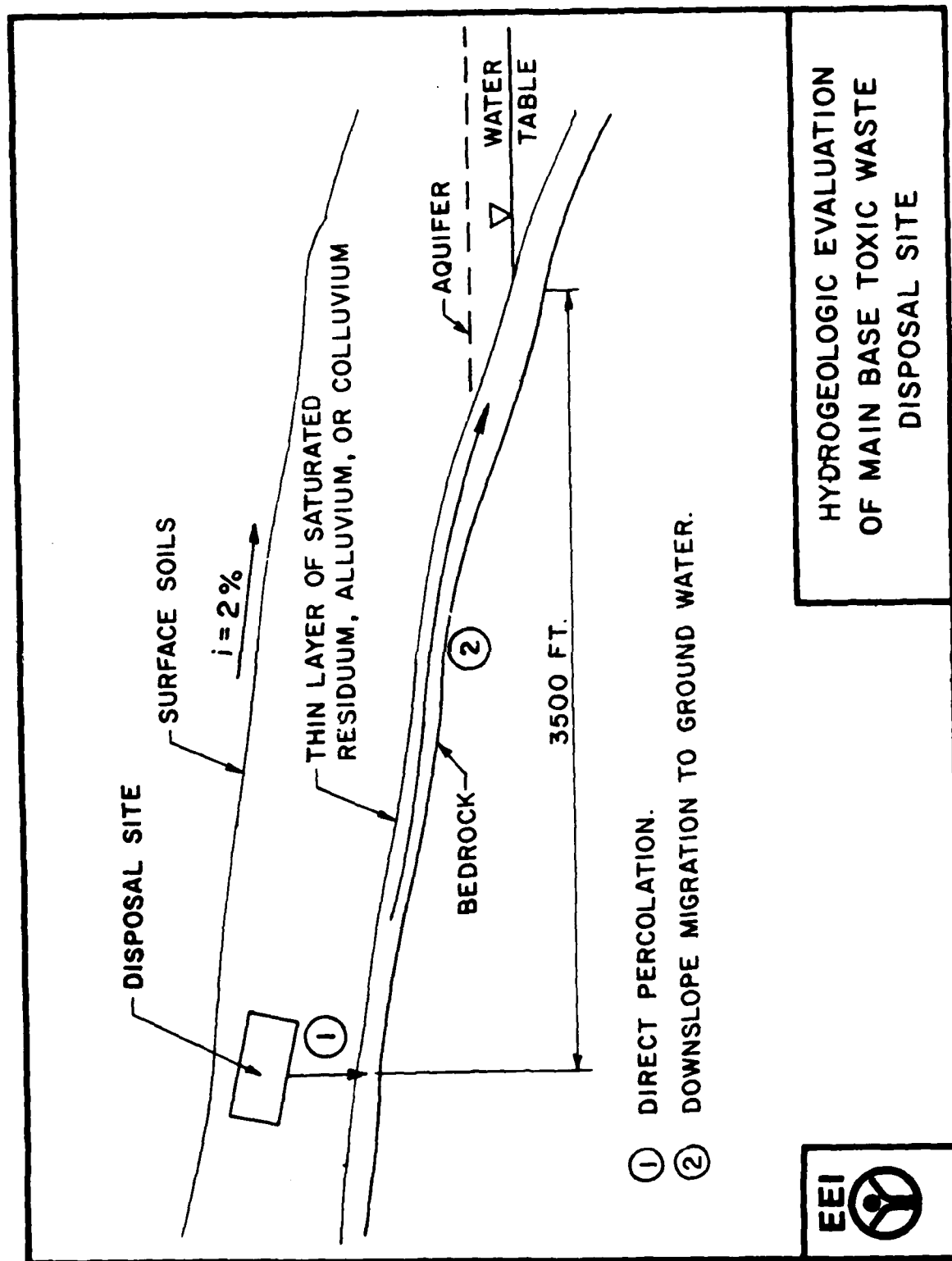


FIGURE 16

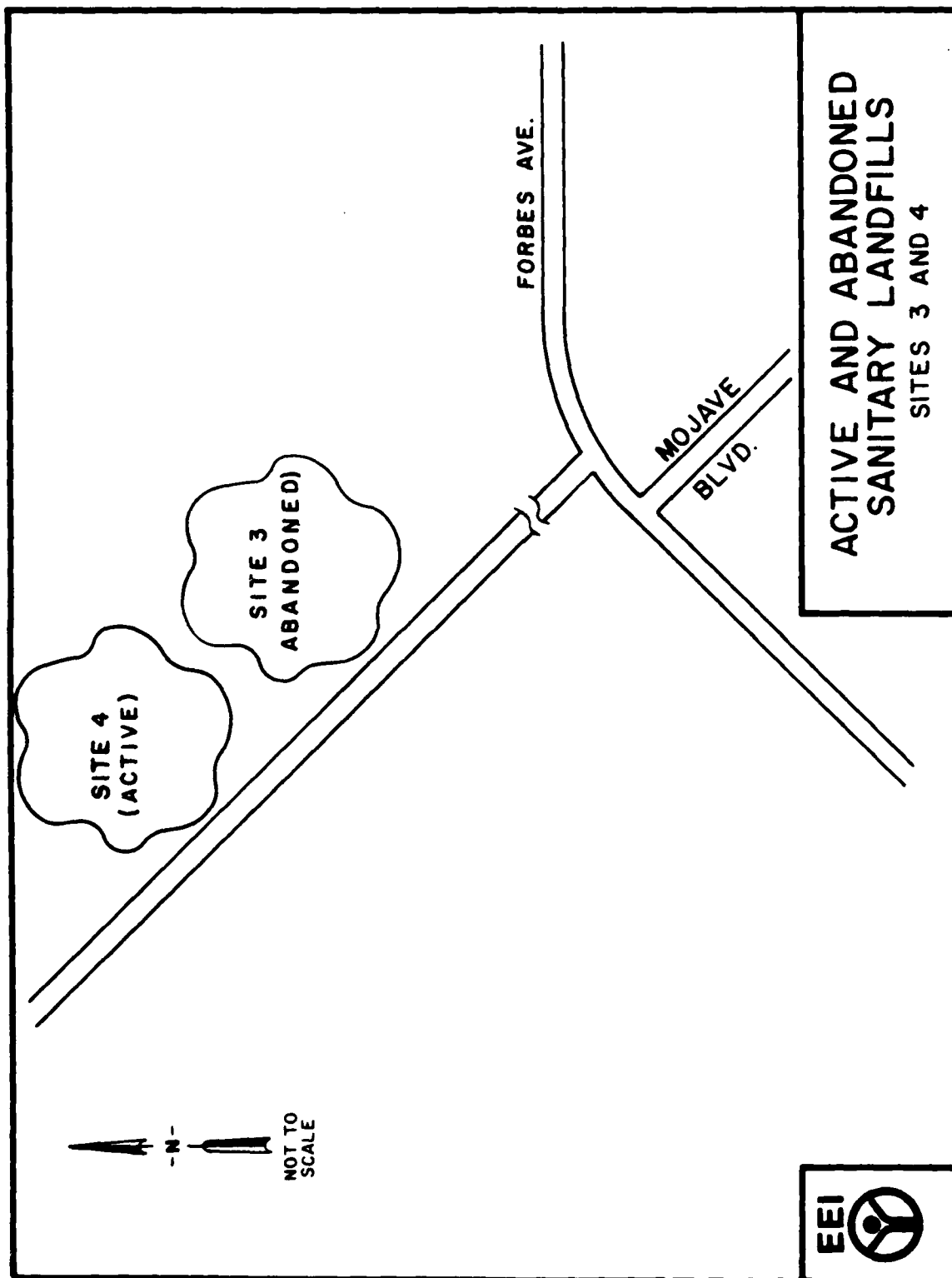


FIGURE 17

the actual operation of the site in the early years. It was primarily operated as a sanitary landfill; however, other waste materials may have been co-disposed along with typical domestic and commercial wastes. There are no monitoring wells or leachate collection systems at the site. It is located in an area that slopes gently toward an arroyo which drains into Rogers Lake and is relatively isolated from the other Main Base activities.

The surficial soils are sandy and are part of an area that has been mapped as a Younger Fan Deposit (Qya).

Rating and Evaluation - This site received an overall score of 71 percent. Waste characteristics and waste management practice subscores were 88 percent and 83 percent, respectively. These subscores might be artificially high since the hazard potentials were based on the possibility that hazardous wastes and banned pesticides were co-disposed with typical domestic and commercial wastes.

The landfill is in an area of moderately sloping topography (1 to 3 percent). This encourages runoff and inhibits infiltration of precipitation. When vegetated, the amount of precipitation available for leaching of buried wastes will be further reduced. Because of the mixture of materials disposed of at the landfill, direct percolation of liquids seems highly unlikely. Therefore, leaching is the only possible mechanism

for subsurface contaminant transport. With so little moisture available for leaching, it appears that this site will have minimal potential for contaminating groundwater.

Active Main Base Sanitary Landfill: Site 4

Site Location - NE 1/4, SW 1/4, Sec. 21, T10N, R38E

This site consists of two main cells covering approximately 1 square mile (see Figure 17), situated directly northwest of the abandoned sanitary landfill and in the same topographic setting. Start-up occurred in 1975 and the site is expected to be in use for at least another 20 years. Operational procedure dictates that each day's fill material be covered with 6 inches of soil at the end of each working day. Wastes at this site include typical domestic and commercial refuse. It is doubtful that any chemical wastes are being disposed of at this site due to strict Air Force controls and regulations governing chemical waste management practices. The California State Water Quality Control Board (Lahontan Region) inspects the landfill and issues a permit for operation.

As at the Abandoned Main Base Sanitary Landfill, the surficial soils at the active site are sandy, and the surficial geologic unit is Younger Alluvium (Qya).

Rating and Evaluation - The Active Main Base Sanitary Landfill received a low overall score of 50 percent. This is reflected by the extremely low subscores for site evaluation and waste management practices (33 percent and 38 percent, respectively). Low scores indicate low potential for hazards. The hydro-geologic evaluation of this site is identical to that of the Abandoned Main Base Sanitary Landfill because the sites are located in the same area. Similarly, this site will have minimal potential to contaminate the groundwater.

South Base Waste POL Storage: Site 5

Site Location - NE 1/4, SE 1/4, Sec. 1, T10N, R38E

This site consists primarily of four underground storage tanks with a 50,000 gallon capacity each (see Figure 18). These tanks were installed around 1940 and are probably constructed of stainless steel. Also stored at this site are approximately seventy 55-gallon drums. Laboratory test reports from the 3rd and 8th of July, 1980 indicate that these barrels contain water-contaminated petroleum oil, synthetic ester oil, jet fuel, and hydraulic fluid. Test reports also verify that the underground storage tanks contain water contaminated fuels and oils. A sign above Tank 4 indicates that it contains petroleum oil. This tank is known to have leaked, but the quantity is unknown. Topography in this area is flat with sandy soils and very little sign of surface drainage. Even though the site is somewhat removed from most of the Main Base activities, it is completely fenced and the gate is kept locked.

This site is near the edge of Rogers Lake Playa, and is in proximity to Edwards AFB Main Base wells 1 and 3 (Dutcher, et al, 1962). According to the well log, at USGS well number 9/9-6E1 located 1/4 mile northeast of the site, there is 35 feet of sandy clay above the perforated section of the well. The site is in an area that has been mapped as a young alluvial (plain type) deposit (Qya).

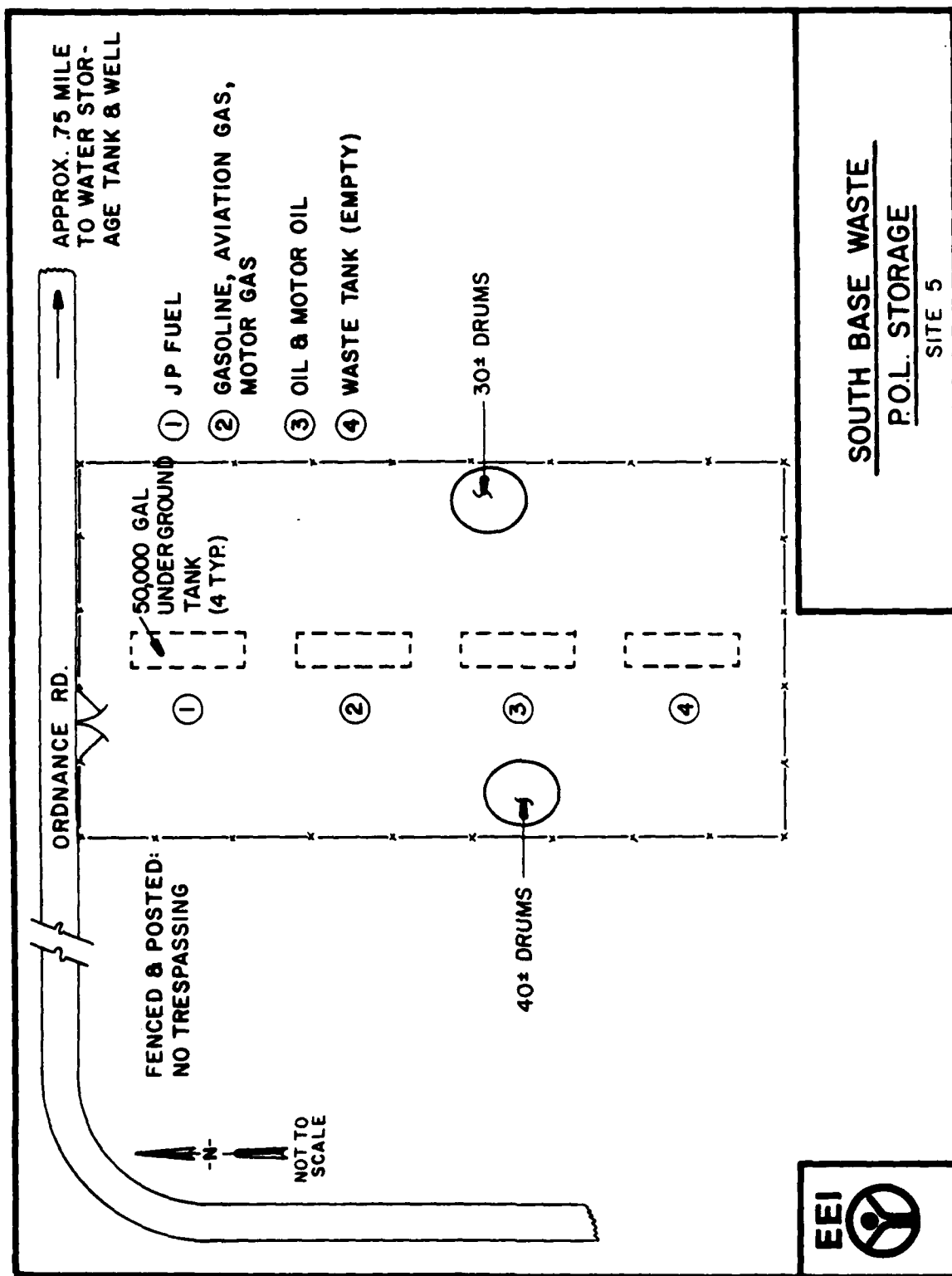


FIGURE 18

Rating and Evaluation - The overall rating score is 67 percent. The method of storage is fairly good; however, the tanks are old and in need of repair as indicated by the leakage of Tank 4. The subscore rating of 81 percent for contamination potential is primarily attributed to known leakage and moderate soil permeability. Another cause for concern is the proximity of Main Base Supply Well 1, which is located within 3/4 of a mile of the site.

The Log of Well 9/9-6E1 indicates that this area consists of sandy clay 35 feet thick above an aquifer. (This well is approximately 1,000 feet northeast of the South Base Site.) The site is located in the Young Alluvium geologic unit, 1-1/4 miles northwest of the edge of Rogers Lake Playa. According to water table maps from 1970, the depth to groundwater is approximately 60 feet, indicating that about 25 feet of aquifer had apparently been dewatered by 1970. Groundwater beneath the site is probably within the capture area (area of influence) of Main Base Supply Well 1 (9/9-6L1) which is located approximately 3/4 of a mile east south-east of the site.

An estimation of the groundwater flow velocity in the vicinity of the site is calculated as follows:

$$v = \frac{ki}{n}$$

where $i = 25 \text{ ft}/2 \text{ mi} = 2.4 \times 10^{-3} \text{ ft/ft}$ (water table gradient)

$n \geq 0.12$ (estimate of minimum effective porosity)

$k \leq 5 \times 10^{-3} (\pm 1) \text{ cm/sec}$ (estimate based on well log)

therefore, $v = 1 \times 10^{-4} \text{ cm/sec} = 100 \text{ ft/yr}$

With a groundwater flow velocity of 100 feet per year and Supply Well 1 located approximately 4,000 feet away, it would take 40 years for any contaminants to reach the well once they enter the groundwater flow system. The distance from the bottom of the tanks to the top of the aquifer may be as little as 15 feet. An estimation of the vertical contaminant migration rate is calculated as follows:

$$t = \frac{Tn}{ki}$$

where t = time to travel distance T

T = thickness of sandy clay beneath tanks

k = coefficient of permeability

i = hydraulic gradient

n = effective porosity

assume $T = 15$ feet

$$k \leq 1 \times 10^{-6} \text{ cm/sec (estimate from well log)} \\ = 1 \text{ ft/yr}$$

$$i \leq 1$$

$$n \geq 0.12 \text{ (from previous calculation)}$$

$$\text{then } t = \frac{15 \times 0.12}{1 \times 1} \approx 2 \text{ years}$$

Chemical leakage from the tanks could reach the aquifer in two years. Since Tank #4 has already leaked, there may be some contaminants from this tank already in the groundwater. It is apparent, however, that the nearest supply well (in the down-gradient direction) may require 40 years of use before contamination of groundwater, but it may take years for contamination to appear in the drinking water. Figure 19 shows a conceptual representation of this mechanism.

Abandoned Mine Shafts: Site 6

Site Location - East 1/2, Sec. 22, T10N, R7W

This site is situated in the upland area east of Leuhman Ridge. The site consists of two mine shafts (see Figure 20) that were used for disposal from the middle 1950s to the middle 1960s. A wide variety of fuels, chemicals, and wastes were disposed of here. The method of storage varied, but cylinders containing pentaborane, high energy fuels (HEF) - 2 and 3, fluorine, tetraethyl boron, and other waste fuels were deposited in the shafts. Hardware and office equipment were also disposed

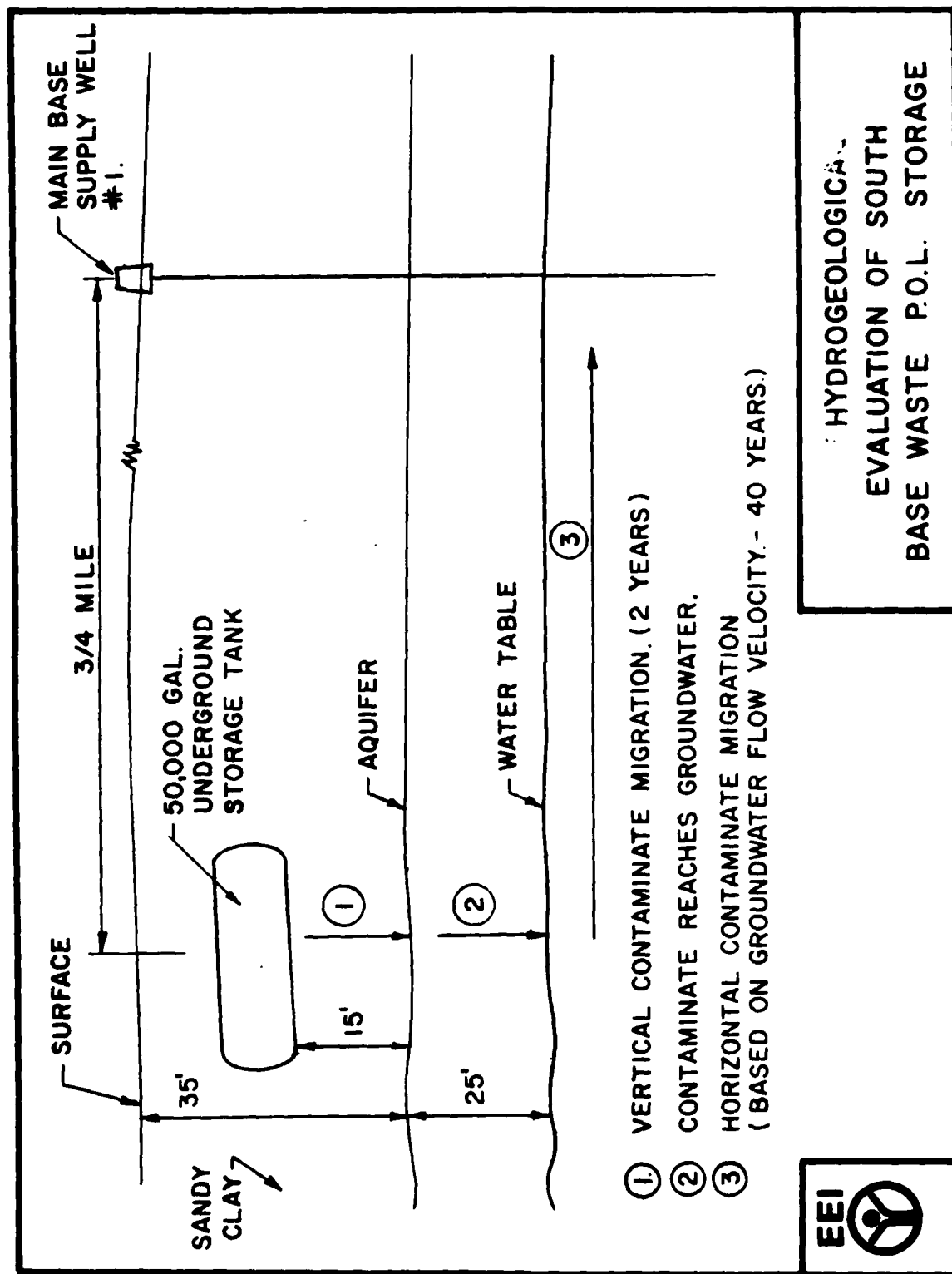


FIGURE 19

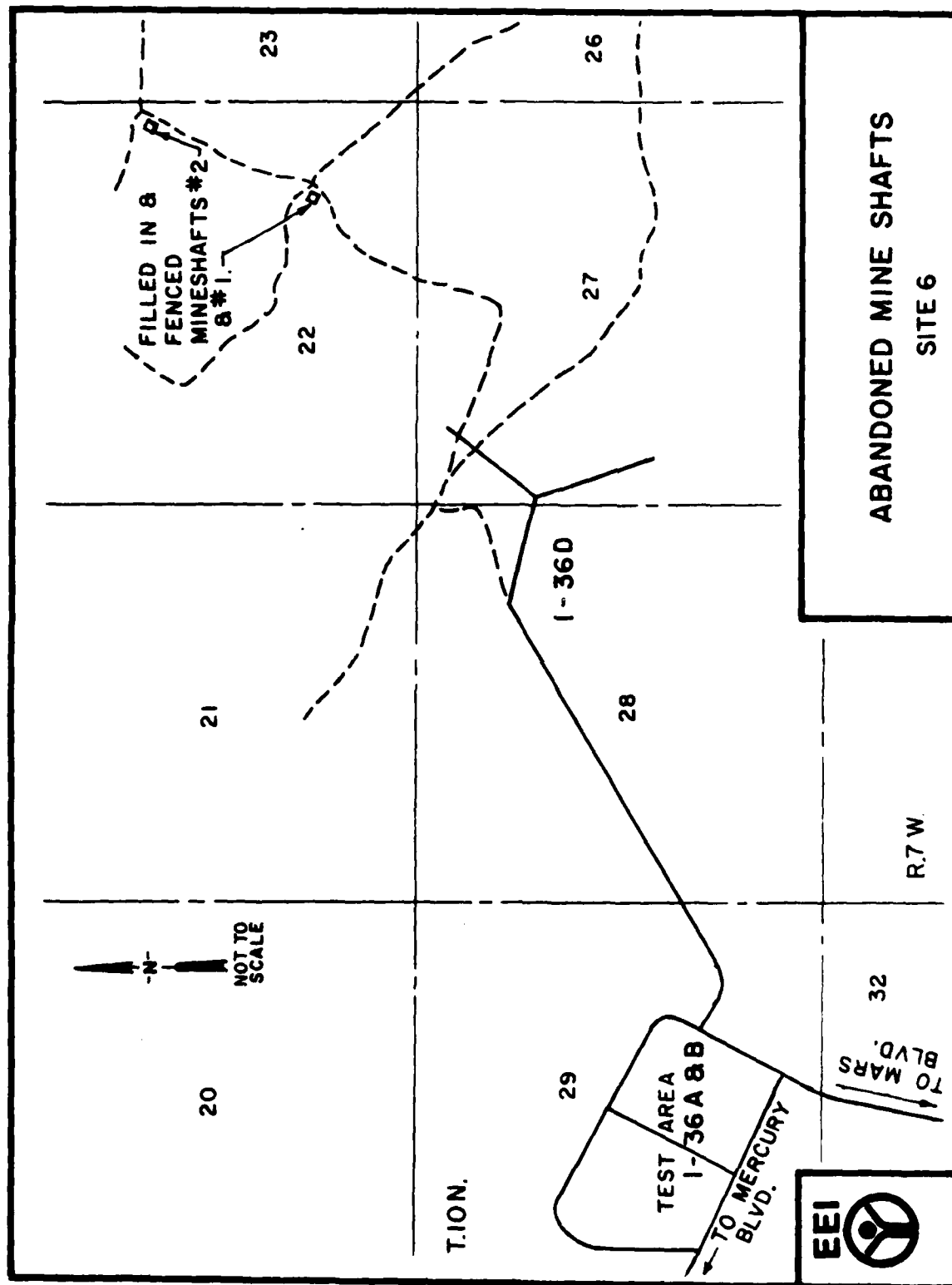


FIGURE 20

of in Shaft #2. The shafts are now filled and covered with soil. The immediate area is fenced and posted, while the site itself is located in a very remote and controlled access area.

The soils at the mine shaft sites are thin residuum. The bedrock is a quartz monzonite (Hughes, 1970). Hughes describes this unit as being essentially impermeable. Because of the mineralogy of the monzonite, it weathers to a coarsely granular residuum that has a high clay content. The clay content is typically high enough to yield a soil of low permeability.

Several faults have been mapped in this area (see Figure 5). The fault shown closest to the mine shafts is the Spring Fault, which passes about 1/2 mile southwest of the southern mine shaft.

Rating and Evaluation - Evaluation of the abandoned mine shafts includes consideration of many factors. Figure 5 illustrates the faults in the vicinity of the shafts. They appear to end before reaching the shafts and, if projected, they pass to the south by 1/2 mile. The surrounding area consists primarily of igneous and metamorphic rocks which do not represent a possible vehicle for contamination.

The overall rating score of 66 percent is in the middle of the range of scores. The waste characteristic subscore of 90 percent is high. However, many of the wastes are probably no

longer at the site. Most of the fuels and propellants were thought to have ignited and burned during fires which occurred when this site was active. Other wastes are stored in metal cylinders which serve to contain the wastes.

The hydrogeologic evaluation of the site locates the shafts several miles from the nearest aquifer and even further from any surface drainage pathways. In order for the waste chemicals to contaminate the groundwater, a migration mechanism must be present. A conservative estimate of the migration was calculated as follows: (1) the mine shafts were estimated to be 12 feet x 12 feet and 100 feet deep and the soils used to fill and cover the shafts to have a minimum 30 percent voids, (2) the net water penetration was assumed to be 3 inches per year, resulting in a rate of saturation of 0.83 feet per year ($3 \text{ inches/year} \div 0.30 = 0.83 \text{ feet/year}$), and (3) a 100 foot deep shaft and a saturation rate of 0.83 feet/year resulted in an estimated minimum of 120 years to saturate the soils from the bottom of the mine shaft where the chemicals are stored up to the ground surface ($100 \text{ feet} \div 0.83 \text{ feet/year} = 120 \text{ years}$).

The rock surrounding the shafts is unweathered and will not allow water to escape (Hughes 1975) (see Figure 21). In order to migrate from the site, the contamination must migrate upward based on molecular diffusion (very slow) to the thin layer of surface soil, and then migrate horizontally. The mine shaft

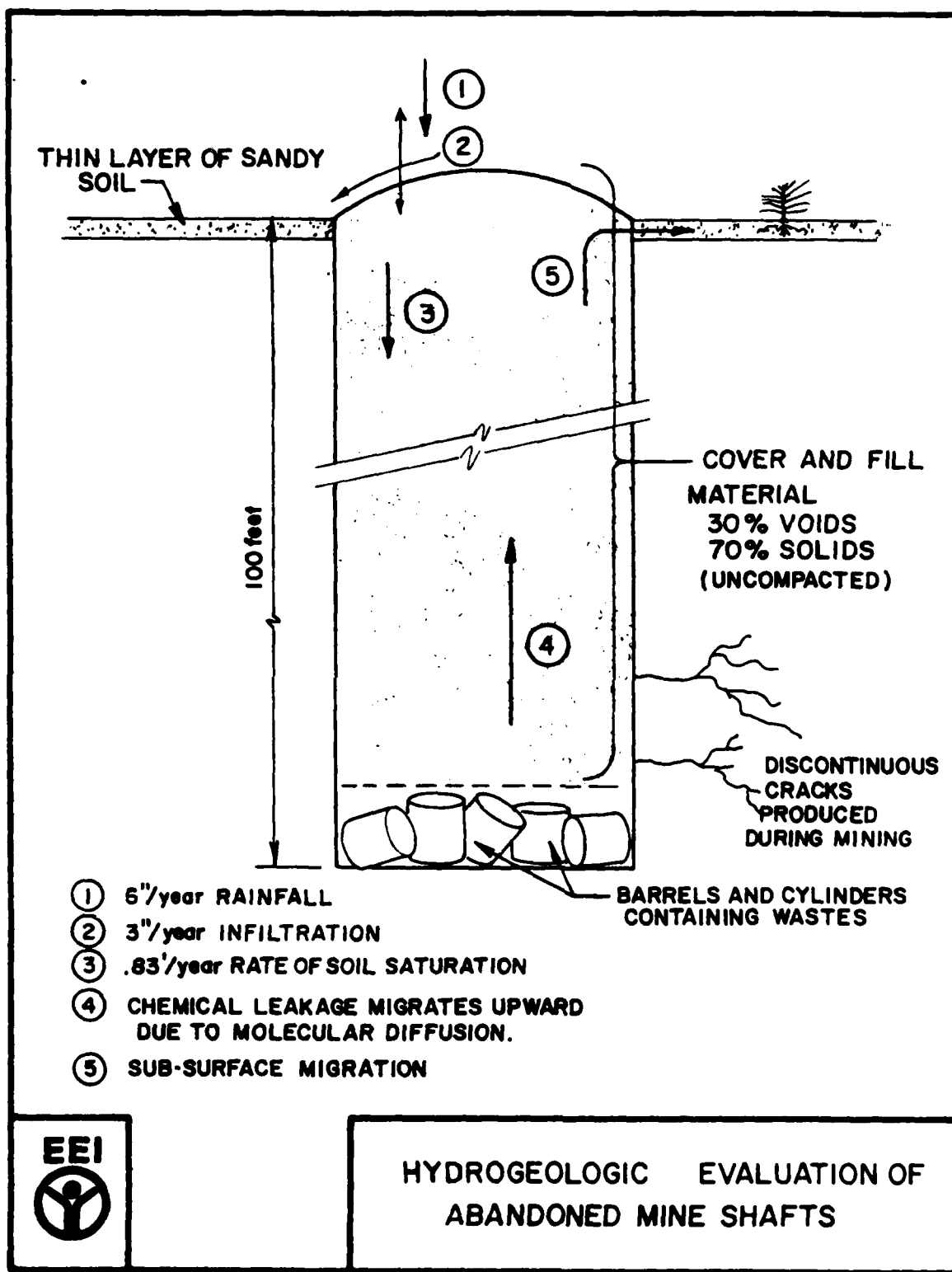


FIGURE 21

opening of 144 square feet represents a very small contribution to the approximately 6 square miles of subsurface drainage area. This represents a dilution factor of 10^6 . Any contamination emigrating from the mine shafts will be insignificant and the overall potential for groundwater contamination is minimal.

Beryllium Contaminated Earth Pile at Rocket Propulsion Laboratory (RPL): Site 7

Site Location - SW 1/4, NE 1/4, Sec. 8, T9N, R41E

The size of the Beryllium Contaminated Earth Pile is approximately 300 feet long x 15 feet wide x 4 feet high (see Figure 22). The majority of the soil at this site (top 6 inches) was removed from the area of the waste fuel treatment facility. This facility is located on a portion of the test grid pattern from the beryllium firing programs of the 1960s. The soil was relocated to prevent construction workers from contacting beryllium contaminated soils during construction of the treatment facility in 1972. Small mounds of rubble on top of the earth pile are from the explosion of Building 9402. Building debris and the top 3 inches of soil from around the building were relocated to the earth pile in the mid-1970s. The earth pile is fenced and posted. It is located approximately 300 yards north of the waste fuel treatment facility on a very gentle grade with no signs of water present.

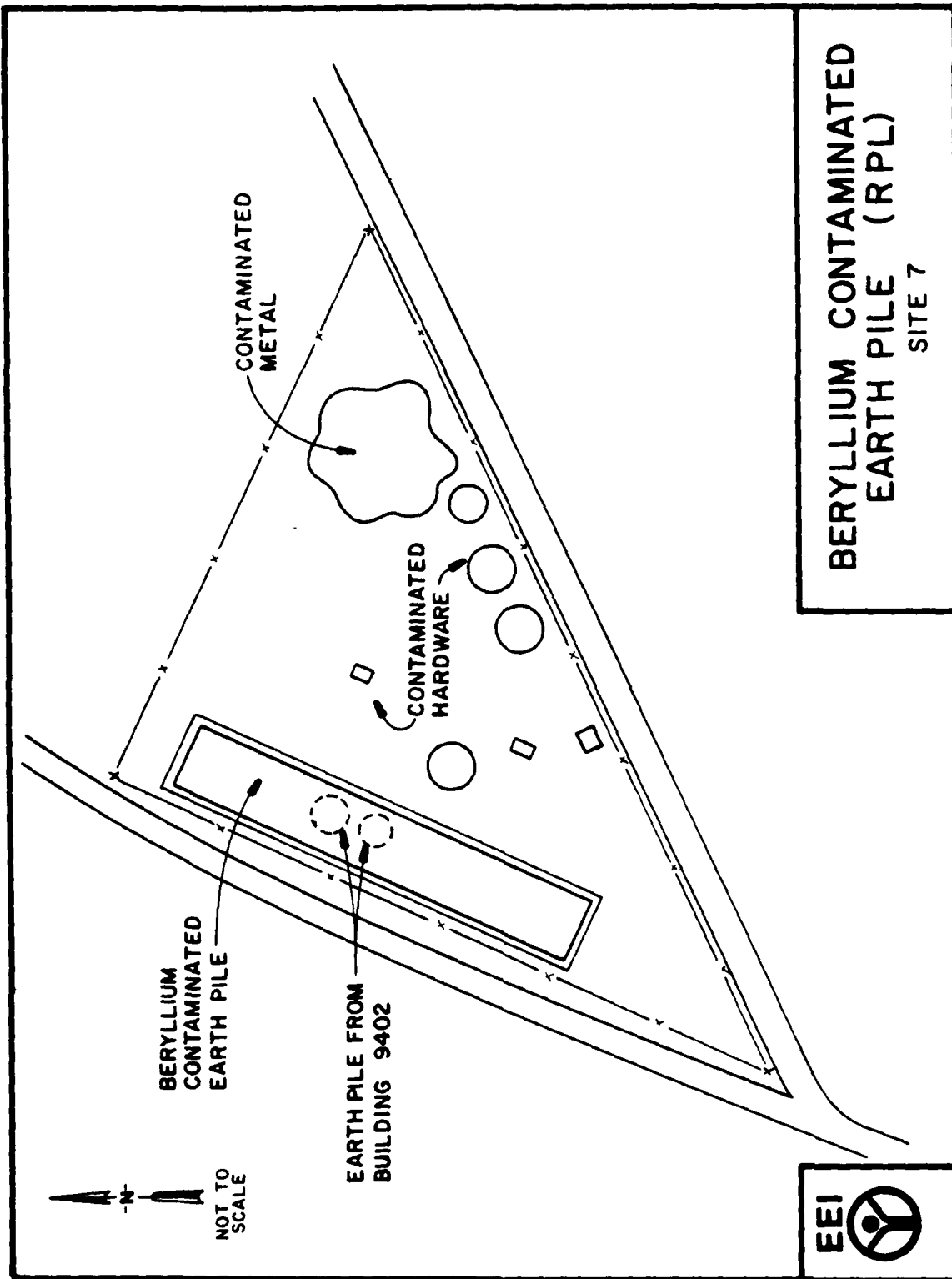


FIGURE 22

The soils at this site are thin granular residuum. They are probably similar in composition (same bedrock unit), but not as coarse at the surface as the residuum at the Abandoned Mine Shafts site. The nearest known occurrence of groundwater (Hughes, 1970) is in the valley which drains this site, located approximately 1-1/2 miles to the east. Hughes indicated that groundwater in this valley is moving very slowly (1×10^{-4} feet per year) toward the southeast. The topography at the site slopes to the east without any breaks at about a one percent slope.

Rating and Evaluation - The overall rating score of 55 percent for this site is low. Waste characteristic hazard potentials are based on beryllium which is very toxic even in small amounts. However, the total amount of beryllium contained in the pile is estimated to be very small.

The soils around the pile consist of thin residuum/colluvium over pre-Tertiary bedrock. Some alluvial fan deposits occur within 1/2 mile downslope. Leaching would be a very negligible transport mechanism due to the low precipitation and high evaporation. In addition, the slope of the pile encourages runoff, and the solubility of beryllium oxide is low. Transportation of beryllium soil particles by runoff is the only possible mechanism when considering groundwater contamination.

The average concentration of beryllium oxide in the pile is probably less than 10 ppm based on Air Force Communications of September 14, 1972. A high erosion rate of 1/2 inch/year or 0.42 feet/year is assumed, and the density of the pile may be as high as 110 pcf (dry).

The area of the pile is estimated at 300 feet x 45 feet - 13,500 feet². The total amount of beryllium to be transported is calculated as follows:

$$a = 13,500 \text{ feet}^2 \times 0.42 \text{ feet/year} \times \frac{110 \text{ lb}}{\text{feet}^3} \text{ by } 10 \text{ ppm}$$

$$= 0.6 \text{ pounds of Be (as BeO)}$$

The 0.6 pounds of beryllium is contributed to a drainage area of approximately 31 square miles at the point where the topography flattens out and infiltration becomes significant (southeast corner of Sec. 21, T9N, R6W). Assume that 1 inch/year of runoff (minimum) occurs in the drainage area (4.4×10^9 pounds of water per year runoff). If all of the 0.6 pounds of beryllium is dissolved, the calculation of beryllium concentration is as follows:

$$[\text{Be}] = \frac{0.6 \text{ pounds Be}}{4.4 \times 10^9 \text{ pounds in H}_2\text{O}}$$

$$= 1.4 \times 10^{-10}$$

This is equivalent to 140 parts per trillion or 0.14 parts per billion, prior to further dilution after the water enters the groundwater.

No drinking water limit has been established for beryllium. The recommended occupational exposure standard is $2 \mu\text{g Be}/\text{m}^3$ (Instrumentation for Environmental Monitoring, Air-Be August 1974, page 7.) Conversion of $2 \mu\text{g Be}/\text{m}^3$ to an equivalent aqueous concentration (allowing for the 1,000 times less toxic factor) computes to be 2×10^{-9} . This is 14 times greater than the maximum concentration that could be derived from the Beryllium Earth Pile. Since the beryllium concentrated in runoff from the pile would have to percolate through the ground and into the groundwater where it would be diluted even further, the beryllium concentration would probably be less than that calculated above (1.4×10^{-10}). Therefore, the Beryllium Earth Pile is considered to have negligible potential for contamination of groundwater.

Industrial Waste Pond: Site 8

Site Location - Western 1/2, SW 1/4, Sec. 30, T10N, R39E

The Industrial Waste Pond serves as a surface impoundment for evaporation (see Figure 23). The pond always contains water and is built with earthen dikes on Rogers Dry Lake bed adjacent to the NASA flight line. Start-up of this impoundment occurred in the middle 1950s. Runway run-off and wash down, fuel spills and wash down, and drainage from the hangers all enter the pond. Content of the pond is primarily water, since the water goes through an oil separator before it enters the pond. The

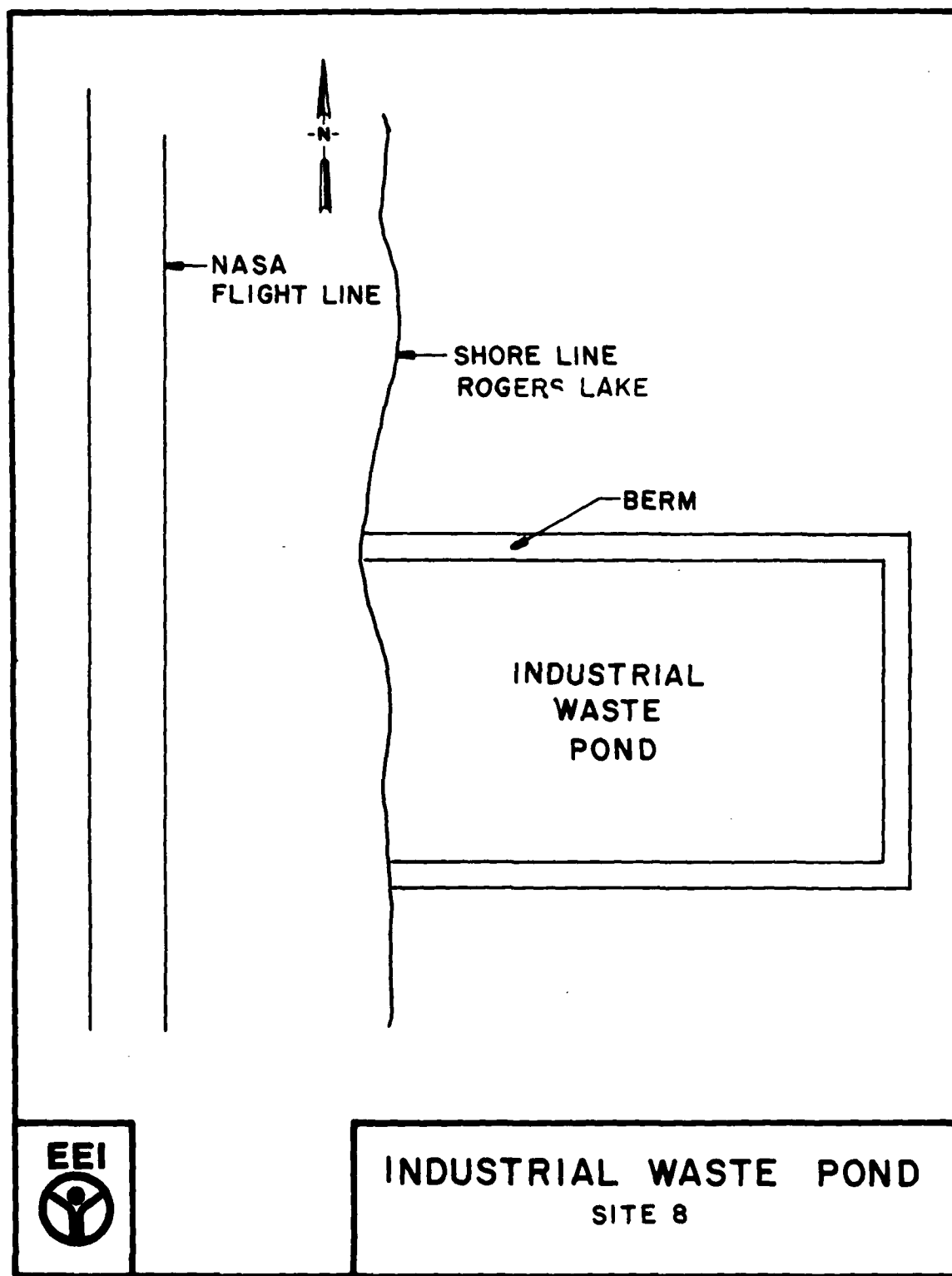


FIGURE 23

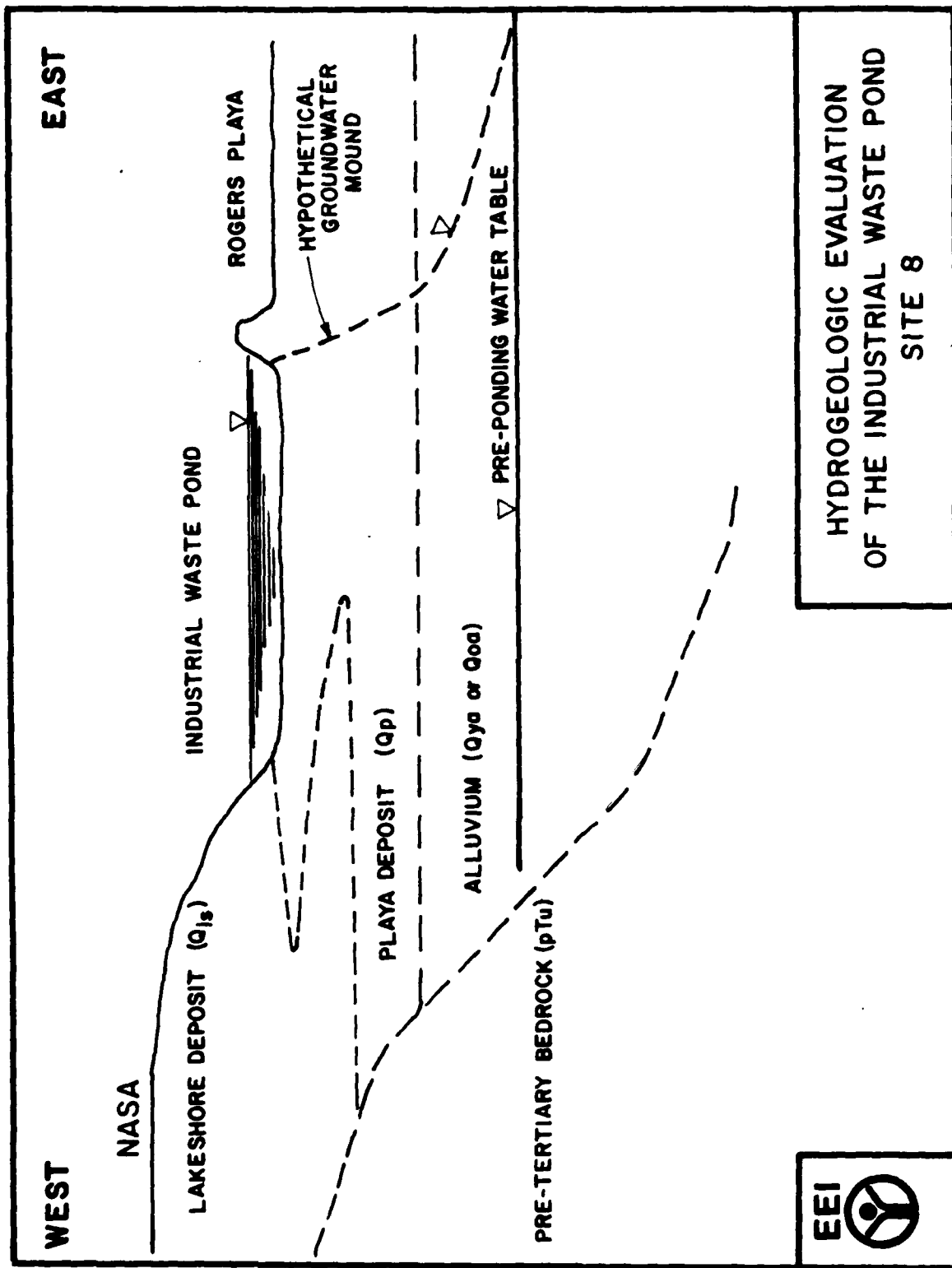


FIGURE 24

California State Water Quality Control Board (Lahontan Region) inspects the site and has issued a permit for the facility.

This pond is located directly on Rogers Dry Lake at its west edge. The dikes surrounding the pond are clay. No giant desiccation fissures were noted in the immediate vicinity of the pond. The surficial deposits adjacent to the edge of the lake have been mapped as Lakeshore Deposits (Q_{1s}). Pre-Tertiary bedrock crops out at the edge of the lake just south of the pond. Therefore it appears likely that the Lakeshore Deposits at the pond are thin and discontinuous.

Rating and Evaluation - The overall rating score of 48 percent is very low. The highest subscore rating was 59 percent for contamination potential. However, this score is not as high as it probably should be due to the year-round ponding factor (Braun) not considered on the score sheet.

The hypothesized geology of the site is shown in Figure 24. The hydrology of this site is thought to be similar to that of the sanitary oxidation/evaporation ponds where year-round ponding has been shown to produce a groundwater mound in the underlying deposits.

The artificial recharge rate is slow but measureable. At the sanitary ponds, the size of the mound indicates a recharge

rate of a few inches per year. It is expected that the recharge rate from the Industrial Wastewater Pond is similar.

Regular analyses of water samples from the Industrial Wastewater Pond indicate that the water is of reasonably good quality. No analyses have been conducted on sediment in the pond. The quality of the water recharging the underlying aquifer is expected to be chemically similar to the water in the pond, with some modification occurring as the water seeps through the sediment and upper soil layers in the bottom of the pond. This modification may include an increase in sodium chloride, sulfate and hardness (from the alkaline playa soils), and a decrease in nitrogen (denitrification within the sediments).

Since the analyses conducted on the pond water samples have included only classical parameters such TOC, little can be said regarding the potential for groundwater contamination by trace organics such as solvents or jet fuel components. However, if such substances are present in the pond water, they will probably also be present in groundwater beneath the site. This site has potential for contamination of the groundwater.

Petroleum Spillage Containment Pond: Site 9

Site Location - NE 1/4, SE 1/4, Sec. 23, T10N, R38E

The Petroleum Spillage Pond is approximately 30 feet long x

20 feet wide x 3 feet deep (see Figure 25). Earth dike walls were used to create the pond. Dust binder and asphaltic sealer are stored in nearby tanks. Overfill and spillage from these tanks drain into the pond and form a very thick mixture. The start-up date of this pond is unknown. No leakage from the pond is visible. The site is located on a gentle slope which drains towards the east.

This gently sloping ground is part of an alluvial fan. The area has excavated roadbed material dumped around the site. The dikes are probably constructed of a very fine-grained material which makes them very impermeable, especially to the very thick tar-like substance contained therein. Weathered rock underlies the surficial loose sand. The rock in the area is undifferentiated pre-Tertiary rock.

Rating and Evaluation - The overall rating score is low (55 percent). The subscores for each main category are 69 percent or lower, indicating low hazard potentials. The ability of the contents of the pond to migrate appears very minimal since the mixture is very thick and viscous.

Geologic data indicates the area to be thin residuum and/or colluvium over pre-Tertiary bedrock. Groundwater maps show no underlying aquifers near the pond. The pond is located 1/2 mile

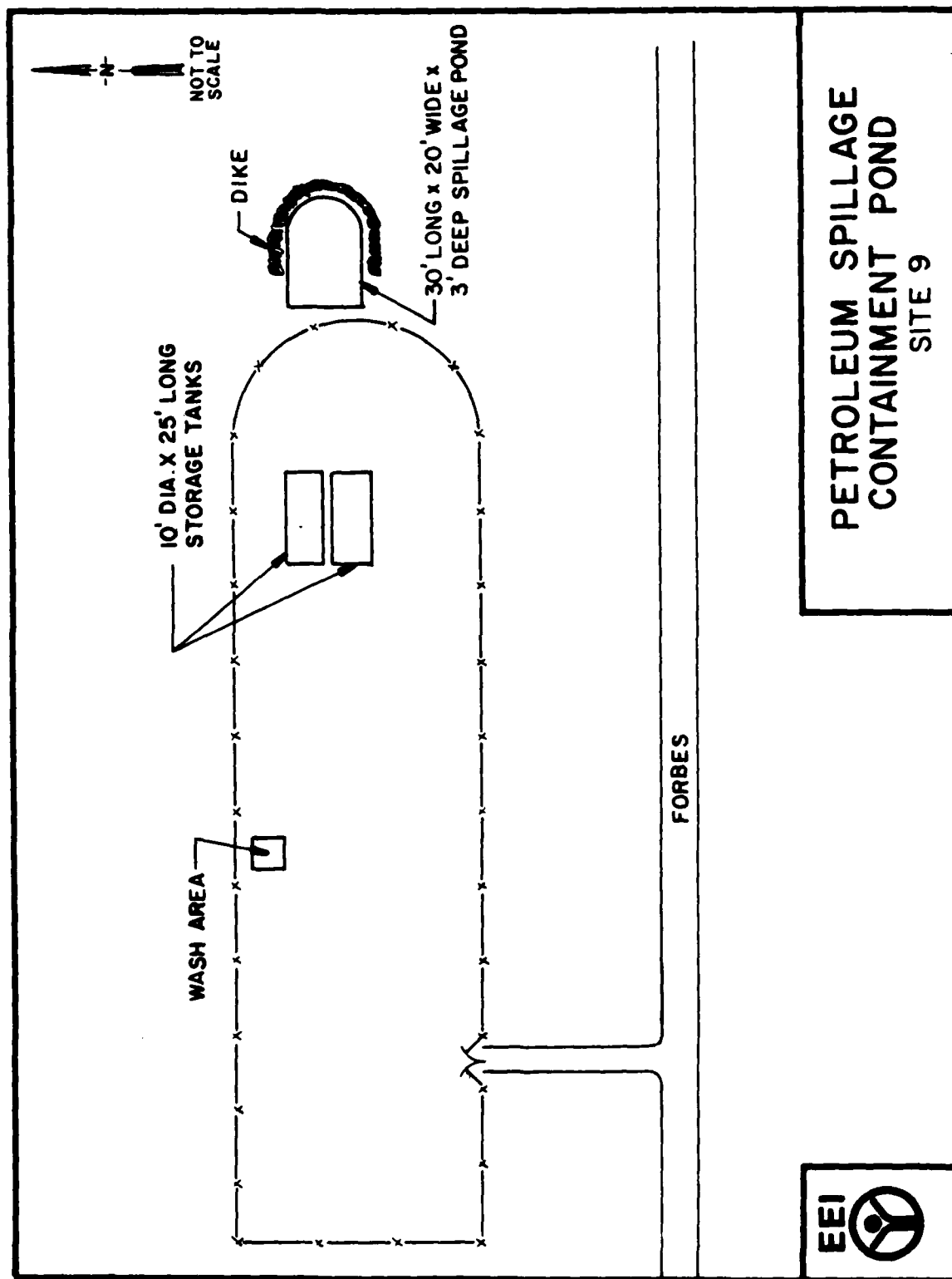


FIGURE 25

from the top of a gentle slope. There is little or no potential for groundwater recharge upslope. In all probability, there is no groundwater beneath the site.

The pond contains very viscous materials. Only small and infrequent amounts of water flow into the pond. Leaching is not likely since there is no long term ponding of water. Direct percolation is the only possible mechanism for migration. The viscosity of the material in the pond is much higher than water. Therefore, the flow rate in the soil would be as much as three to four orders of magnitude slower.

An estimation of the time required for contamination of groundwater is based on the following calculation:

$$\text{maximum migration rate } v = \frac{ki}{nN_r}$$

where $k \leq 1 \times 10^{-3}$ cm/sec = 1,000 feet/year assuming residuum/colluvium has a high aqueous coefficient

$$i = 0.03 \text{ (slope of ground surface)}$$

$$n \geq 0.12 \text{ (porosity)}$$

$$N_r \geq 10^3 \text{ (relative viscosity - Handbook of Chemistry and Physics).}$$

$$v = \frac{1,000 \text{ feet/year} \times 0.03}{0.12 \times 10^3}$$

$$= 0.25 \text{ feet/year}$$

$$\text{time to travel to groundwater } t = \frac{D}{v}$$

where D = distance to nearest aquifer (5,280 feet)

$$v = 0.25 \text{ feet/year}$$

$$t = \frac{5,280 \text{ feet}}{0.25 \text{ feet/year}}$$

$$= 21,120 \text{ years}$$

The time to travel to the nearest groundwater is over 20,000 years. Therefore, this site has essentially no potential for contamination of groundwater.

CHAPTER 6

RECOMMENDATIONS

The potential for groundwater contamination at each storage and disposal site was determined during the site evaluations described in Chapter 5. The results of those evaluations were utilized to develop the recommendations presented in this chapter.

EEI has assigned an attention priority rating to each site, according to the relative need for remedial treatment.

Number 1 Priority indicates that extensive remedial measures may be required. Sites receiving this classification have a demonstrated or strongly suspected potential for contaminating the groundwater and require remedial actions which may include: waste relocation, construction of secure storage, sampling and chemical analysis for toxic materials, installation of observation wells for groundwater monitoring, or some combination of the above.

Number 2 Priority indicates that limited remedial measures are required. Sites in this classification have little potential for contaminating the groundwater and require limited remedial actions which may include: determining the presence or absence of groundwater by installation of monitoring wells and (at most)

yearly inspections; and conducting additional investigations required to generate pertinent data.

Number 3 Priority indicates that no remedial action is required. These sites have no potential for groundwater contamination for reasons which may include: geological conditions that provide a natural barrier to migration; little or no groundwater present in the area; and waste characteristics of low-hazard potential.

For several of the sites, the recommendations include a phased approach. Since this study did not include any sampling and analysis, verification of contaminant migration where this appears likely is typically included in the first phase. If migration can be discounted through sampling, then monitoring groundwater will not be necessary.

EEI's recommendations for remedial actions are described in the following sections for each site.

NUMBER 1 PRIORITY

North Lake Bed Disposal and Storage Site

Subsite 1A -

Phase I:

- 1) Remove drums from this area. Relocate to a secure storage or disposal area, preferably

one with underlying clay deposits and away from surface waters.

- 2) Conduct subsurface investigation. Collect deep (10 feet) soil samples directly beneath site at three or four locations selected on the basis of the most likely areas for water to pond or infiltrate. Laboratory analyses should then be performed on these samples for positive identification of contaminant migration. The analyses to be conducted should include all of the known or suspected wastes which were or are found at this site.

Phase II: If the results of the Phase I investigation indicate that there has been no significant vertical migration of contaminants, then the removal of the drums in Phase I and any contaminated surface soils would prevent future contamination of the underlying aquifer. If vertical migration of contaminants has already occurred, such that a significant degree of soil contamination is detected at the 10-foot depth, then a groundwater monitoring program should be established.

This program should consist of a minimum of three monitoring sites within 100 feet of the disposal site. Wells should be screened so water at the water table is sampled regardless of fluctuations in the water table elevation. This may require nested "piezometers", at each of the three locations (see Figure 26). The wells should be sampled no more than once per year. Samples should be appropriately analyzed for suspected contaminants.

Subsite 1B -

- 1) Relocate to secure storage area. Store drums in upright position to prevent possible barrel cap leakage.
- 2) Relocate drums from second site as described above.

Subsite 1C - Check pH of surface soil and add lime
(if required) to neutralize.

Subsite 1D -

Phase I:

- 1) Remove drums from this site. Relocate to a secure storage area.

AD-A140 206

INSTALLATION RESTORATION PROGRAM (IRP) PHASE I
ASSESSMENT OF THE POTENTIAL (U) ENVIRODYNE ENGINEERS
INC ST LOUIS MO 30 APR 81 1594 F08637-80-G-0002

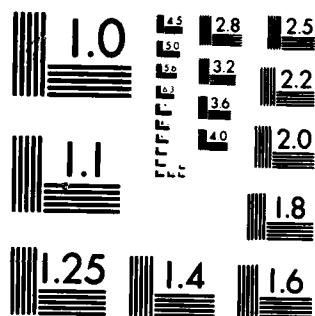
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

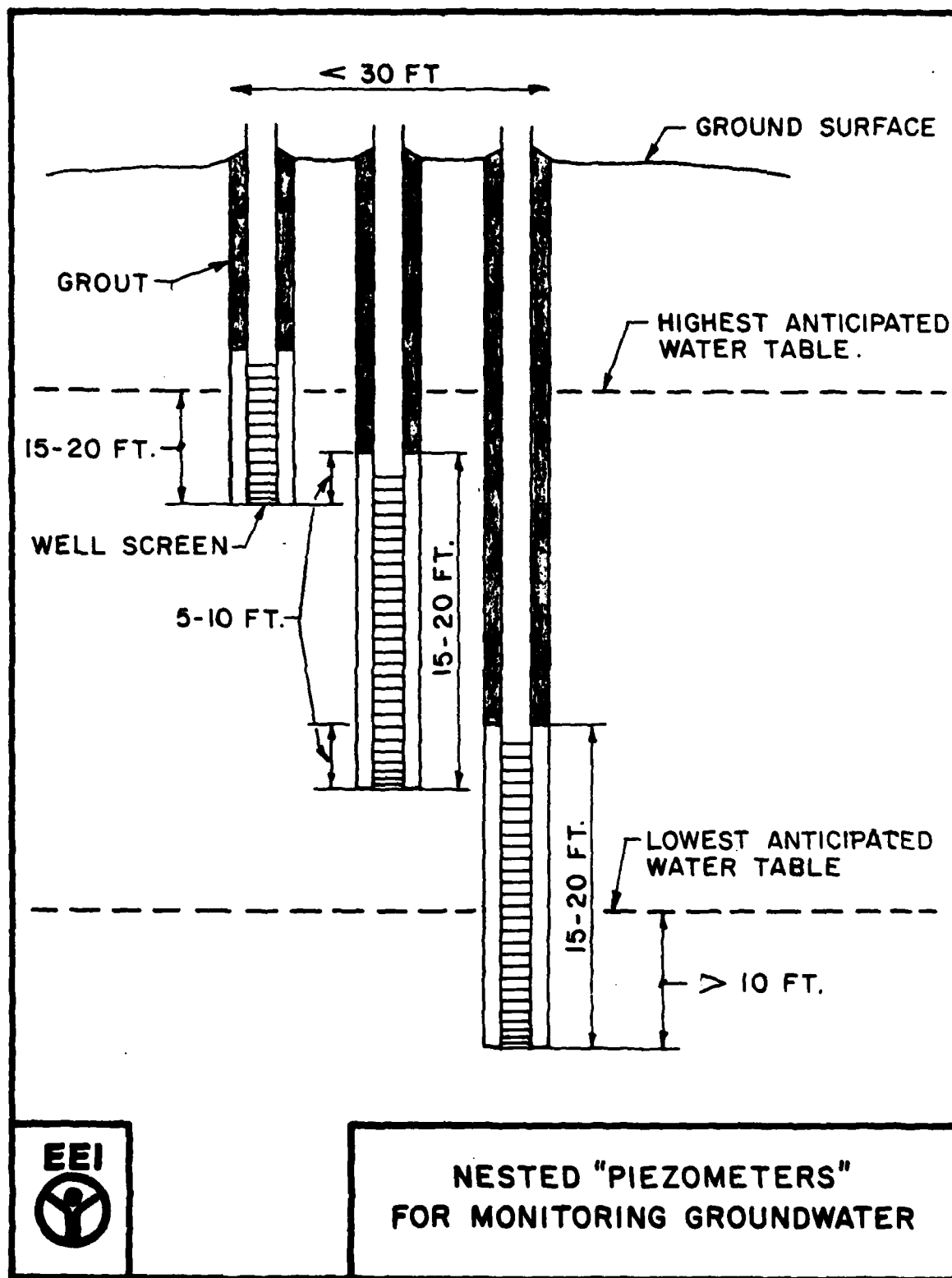


FIGURE 26

- 2) Conduct subsurface investigation. Collect surface and deep (10 feet) soil samples from at least three locations in the bottom of the trenches. Perform laboratory analyses for positive identification of chemical leakage or spillage of any of the known or suspected contaminants at this site.
- 3) Fill in trenches with compacted clay. If soil is significantly contaminated, excavate and remove to proper storage or disposal site. In either case, fill in trenches.

Phase II: As at Subsite 1A, if no significant, vertical migration of contaminants has occurred, removal of the drums and any lightly contaminated surface soil (plus filling in the trenches) would prevent any future contamination of the underlying aquifer at this site. However, if it appears that a significant degree of soil contamination is present at the 10-foot depth, this would indicate that migration has occurred, and that the underlying aquifer may have already been contaminated. Therefore, if the deeper soil samples are contaminated, a groundwater monitoring program should be established (see program outlined for Subsite 1A).

South Base Waste POL Storage Site: Site 5

- 1) Establish groundwater monitoring program
(see North Lake Bed Disposal and Storage
Site - Subsite 1A).

- 2) Inspect the condition of the three tanks
still in use. If the tanks are no longer
useable, they should be properly abandoned.
If the tanks are useable, they should be
periodically monitored for leaks as re-
quired under the RCRA Hazardous Waste
Regulations.

NUMBER 2 PRIORITY

Industrial Waste Pond: Site 8

Phase I - Sample liquid contents and sediment in the pond.
Analyze for the presence of toxic organics (e.g. GC/MS screen).

Phase II - If no toxic organics are present in either the
water or the sediment, then no further action would be called
for. However, if toxic organics are detected, then a ground-
water monitoring program should be established (see North Lake
Bed Disposal and Storage Site - Subsite 1A).

Main Base Toxic Waste Disposal Site: Site 2

Phase I - Install three monitoring wells to determine

whether any groundwater is present. If groundwater is not present, there is no potential for contamination. Collect several (at least six) sediment samples from the bottom of the arroyo adjacent to the site to determine whether contaminants have eroded from the site. One sample should be taken upstream from the site as a background reading. Five samples should be taken at various locations downstream from the site up to a maximum distance of one-quarter mile. Samples must be analyzed for the presence of heavy metals and base/neutral compounds.

Phase II - If groundwater is present above unweathered bedrock, determine the permeability of the saturated soils/ weathered bedrock. If the saturated soils are relatively impermeable (less than 1×10^{-5} cm/sec), there is no significant potential for contaminating an aquifer. If the saturated soils are moderately or highly permeable, the wells should be used to monitor groundwater quality. Samples need to be analyzed no more than once per year, even if the saturated soils are highly permeable.

If the initial six sediment samples indicate that significant amounts of contaminants have eroded from the site, this potential route of contaminant migration should be more thoroughly investigated.

NUMBER 3 PRIORITY

Abandoned Sanitary Landfill: Site 3

No remedial actions are required.

Active Sanitary Landfill: Site 4

No remedial actions are required

Abandoned Mine Shafts: Site 6

No remedial actions are required.

Beryllium Contaminated Earth Pile (RPL): Site 7

No remedial actions are required.

Petroleum Spillage Containment Pond: Site 9

No remedial actions are required.

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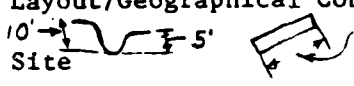
APPENDIX A
FIELD DATA SHEETS

APPENDIX A
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EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name NORTH LAKE BED, DISPOSAL & STORAGE (WEST SITE): SUBSITE 1A
1 OF 4 SUBSITES.
- B. Site Location NORTH CENTRAL BASE AREA, NEAR NORTH BASE
- C. Size/Area/Depth 10' W. x 50' x 5' DEEP
- D. Dates of Operation RECENTLY LOCATED THESE DRUMS (2-3 YEARS)
NOT NOW IN USE!
- E. Method of Disposal CLOSED DRUMS WITH SOME BLATENT OPEN DUMPING.
- F. Site Physical Layout/Geographical Conditions ABANDONED ROAD ELL.
- G. Conditions at Site  200' L x 10' W. DRAINAGE OBVIOUSLY
PRESENT.
1. Soil Condition SANDY - NO VEG. IN DEAD AREA.
 2. Vegetation Present 50' ALONG VALLEY VOID OF VEGETATION
 3. Water or Drainage Mechanisms Present WATER NOT PRESENT / IN A
DRAINAGE AREA. (VALLEY.)
 4. Condition of Containers GOOD CONDITION
 5. Indication of Chemical Leakage YES - SOIL BLACKENED.
- H. Types and Characteristics of Wastes at Site - 13 DRUMS TOTAL
1/3 OF THESE EMPTY
1. MOTOR OIL (10 S.A.E.) - 6 @ 55 GAL. DRUMS
 2. DRY CLEANING SOLVENT - 2 @ 55 GAL.
 3. LUBE OIL 3 @ 55 GAL
 4. MISC. - CLEANING 2 @ 55 GAL
 5.

13 TOTAL
- I. Other Information SEE SITE MAP FOR LOCATION
- J. Identification of Sources
1. TERRY YONKERS E.A.F.B./C.E.
 2. RAY McDONALD E.A.F.B./FUEL MANAGEMENT
 3. SITE INSPECTION

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name NORTH LAKE BED, DISPOSAL & STORAGE (DRUM STORAGE): SUBSITE 1B
1 OF 4 SUBSITES
- B. Site Location NORTH CENTRAL BASE AREA, NEAR NORTH BASE
- C. Size/Area/Depth #1 10' W. x 200' L
#2 10' W. x 30' L
- D. Dates of Operation MID 1950'S THRU MID 1960'S
- E. Method of Disposal CLOSED DRUMS
- F. Site Physical Layout/Geographical Conditions SITE #1 ON EDGE OF
RODGERS LAKE BOTTOM.
- G. Conditions at Site
1. Soil Condition NORMAL
 2. Vegetation Present VERY NEAR BOTH SITES.
 3. Water or Drainage Mechanisms Present DURING RAINY SEASON WATER COULD
BE PRESENT AT SITE #1, NOT AT SITE #2.
 4. Condition of Containers FAIR TO GOOD
 5. Indication of Chemical Leakage NO SPILLAGE OBVIOUS
- H. Types and Characteristics of Wastes at Site 100 DRUMS TOTAL.
1. GREEN W/YELLOW RING -
GOOD CONDITION - MOSTLY EMPTY (30) @ 55 GAL
 2. RUSTED DRUMS
LIGHT GAUGE - MOST EMPTY (60) @ 55 GAL
 3. MATERIALS DUMPED HERE MOSTLY
CLEANING ALCOHOL, ANILINE, ZILADINE
 4. INSULATING OIL, 1/2 FULL (10) @ 55 GAL
 5. INSULATING OIL, 2% CYCLOHEXANONE (6) @ 55 GAL
ALL EMPTY.
- I. Other Information SEE SITE MAP FOR LOCATION
- J. Identification of Sources
1. TERRY YONKERS
 2. RAY McDONALD
 3. SITE INSPECTION.


EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name NORTH LAKE BED, DISPOSAL & STORAGE (NITRIC ACID TRENCHES.)
1 OF 4 SUBSITES : SUBSITE 1C
- B. Site Location NORTH CENTRAL BASE AREA, NEAR NORTH BASE
- C. Size/Area/Depth #1. 20'W. x 150'L. x 3' DEEP
#2. 30'W x 40'L. x 1' DEEP
#3 10'W x 50'L x 1' DEEP #4 100'W x 125'L x 1' DEEP
- D. Dates of Operation 1950-1960 OPEN AREA NO COVER MATERIAL
- E. Method of Disposal OPEN POURING ONTO GROUND / WATER ADDED FOR DILUTION.
- F. Site Physical Layout/Geographical Conditions
FLAT AREA / APPROX. 1' ABOVE LAKE BOTTOMS
- G. Conditions at Site
1. Soil Condition DARKENED / BARREN / VERY SOFT / VERY FINE - DUSTY
DISCOLORATIONS. SEE SOIL SAMPLE REPORT 11 AUG 1977
 2. Vegetation Present
NOT AT SITES #1 AND #3. YES AT SITE #2.
 3. Water or Drainage Mechanisms Present
NO WATER / NO DRAINAGE
 4. Condition of Containers N.A.
 5. Indication of Chemical Leakage N.A.
- H. Types and Characteristics of Wastes at Site
1. FUMING WHITE & RED NITRIC ACID-@ 1000 TO 1500 GAL / WEEK
PLUS 1000 GAL. OF WATER.
 - 2.
 3. ALSO, USE TO BURN OR NEUTRALIZE WASTE ROCKET PROPELLANTS
AND FURFURYL ALCOHOLIN FLAT BOTTOM METAL PAN.
 - 4.
 - 5.
- I. Other Information SEE SITE MAP FOR LOCATION
- J. Identification of Sources
1. TERRY YONKERS E.A.F.B. / C.E
 2. RAY McDONALD E.A.F.B. / FUEL MANAGEMENT
 3. SITE INSPECTION

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name NORTH LAKE BED, DISPOSAL & STORAGE (BARREL TRENCHES)
1 OF 4 SUBSITES: SUBSITE 1D
- B. Site Location NORTH CENTRAL BASE AREA - NEAR NORTH BASE
- C. Size/Area/Depth  #1. 15' W. x 200' L x 10' DEEP
#2. 30' W. x 150' L x 8' DEEP
- D. Dates of Operation ACTIVE 1950'S / CLOSED LATE 50'S.
- E. Method of Disposal 55 GAL. DRUMS
- F. Site Physical Layout/Geographical Conditions TRENCH DUG OUT BY BULLDOZER
/ ABOVE LAKE WATER LEVEL
- G. Conditions at Site
1. Soil Condition NORMAL
 2. Vegetation Present (SOME)
 3. Water or Drainage Mechanisms Present SIDES OF TRENCHES SHOW WASHING
INTO TRENCH.
 4. Condition of Containers FAIR.
 5. Indication of Chemical Leakage SOME LEAKAGE
- H. Types and Characteristics of Wastes at Site
- | | | |
|---|---|-----------------------------------|
| 1. ANILINE OIL | } MOST OF THESE
ARE NOW EMPTY
BARRELS. DRUMS
PITTED AND
CORRODED. | #1 (100) DRUMS OPENLY VISIBLE |
| FURFURYL ALCOHOL | | |
| 2. ENGINE CLEANER (PDQ) | | |
| CUTTING OIL | | #2 (400) DRUMS
OPENLY VISIBLE. |
| 3. ETHYL ALCOHOL | | |
| 4. POTASSIUM PERMANGANATE (DUMPED - OPEN VALVE) | | |
| POURED OUT ONTO THE GROUND INTO TRENCH #1. | | |
| 5. OTHER POSSIBLE MATERIALS - TRICHLOROETHYLENE. | | |
| 6. SEE CHEMICAL ANALYSIS REPORT OF 1 DEC 1978. | | |
- I. Other Information
SEE SITE MAP FOR LOCATION.
- J. Identification of Sources
1. TERRY YONKERS
 2. RAY MCDONALD → REFERRED TO REPORT ON ANALYSIS OF
ALL DISPOSAL AREAS → [SEE JIM BAKER.]
 3. SITE INSPECTION.

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name MAIN BASE TOXIC WASTE DISPOSAL AREA.: SITE 2
- B. Site Location NORTH OF MOJAVE AVE. / JUST EAST OF LANCASTER ROAD.
- C. Size/Area/Depth 1000' W. x 1500' L WITH 6' HIGH CHAIN LINK AND 2' BARBED
ACTUAL BURIAL SITE 35' W. x 450' L. WIRE.
- D. Dates of Operation FIRST USED IN 1953 OR 54 / CLOSED 1960 OR 61.
- E. Method of Disposal UNKNOWN - MOST OF THE CHEMICALS POURED OUT.
SOME IN BARRELS OR DRUMS.
- F. Site Physical Layout/Geographical Conditions SLIGHT SLOPE DOWN FROM N. TO S. 6 % GRADE, POSTED KEEP OUT,
- G. Conditions at Site NO DUMPING, INDICATION OF MATERIAL
BURIED.
1. Soil Condition TOP SOIL GOOD / SEE REPORT - 11 AUG. 1977.
 2. Vegetation Present YES, AND WILDLIFE
 3. Water or Drainage Mechanisms Present NO, SOME DRAINAGE
 4. Condition of Containers N. A.
 5. Indication of Chemical Leakage N. A.
- H. Types and Characteristics of Wastes at Site
1. CYANIDE
 2. CHROMATE
 3. NITRIC ACID
 4. TETRAETHYL LEAD, H_2O_2 , J.P. 5 FUEL, ROCKET FUEL FILTERS.
 5. OTHER POSSIBLE MATERIALS - CHROMIUM, HEAVY METALS, ELECTRO-
PLATING WASTES.
- I. Other Information SEE SITE MAP FOR LOCATION, SEE REPORT ON ANALYSIS OF DISPOSAL
AREAS.
- J. Identification of Sources
1. TERRY YONKERS
 2. SITE INSPECTION,

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name ABANDONED MAIN BASE SANITARY LANDFILL: SITE 3
- B. Site Location NORTH AND WEST OF THE INTERSECTION OF FORBES AND MOJAVE BLVDS.
- C. Size/Area/Depth APPROX 150 ACRES.
- D. Dates of Operation START-UP MID. 1950S / CLOSURE 1975 1-2 FEET SOIL COVER.
- E. Method of Disposal LANDFILL
- F. Site Physical Layout/Geographical Conditions FLAT TERRAIN/NO FENCE
- G. Conditions at Site NOTE: SITE HAS BEEN ABLAZE SEVERAL TIMES SINCE CLOSING.
1. Soil Condition N.A.
 2. Vegetation Present SOME
 3. Water or Drainage Mechanisms Present NONE.
 4. Condition of Containers UNKNOWN
 5. Indication of Chemical Leakage UNKNOWN
- H. Types and Characteristics of Wastes at Site
1. MISC. LANDFILL WASTES. AT THE TIME OF OPERATION WASTES WERE NOT SEPARATED. A STRONG POSSIBILITY EXISTS THAT H.W. WERE
 2. LANDFILLED ALONG WITH TYPICAL DOMESTIC AND COMMERCIAL WASTES, ANOTHER POSSIBILITY IS THE LANDFILLING OF BANNED
 3. PESTICIDES,
 - 4.
 - 5.
- I. Other Information SEE SITE MAP FOR LOCATION.
- J. Identification of Sources
1. SGT. WHITLOCK E.A.F.B.
 2. SITE INSPECTION.

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name ACTIVE MAIN BASE SANITARY LANDFILL ; SITE 4
- B. Site Location N.W. OF ABANDONED LANDFILL
N.W. OF INTERSECTION OF FORBES AND MOJAVE BLVDS.
- C. Size/Area/Depth TWO MAIN CELLS, 1 SQ. MILE AREA.
- D. Dates of Operation START-UP 1975 / IN OPERATION NOW - 6" SOIL COVER
AT THE END OF EACH WORKING DAY.
- E. Method of Disposal LANDFILL
- F. Site Physical Layout/Geographical Conditions LOCATED ON GRADUALLY SLOPING
HILL ; N.E. SIDE OF N.W. - S.E. VALLEY.
- G. Conditions at Site
1. Soil Condition N.A.
 2. Vegetation Present N.A.
 3. Water or Drainage Mechanisms Present NONE
 4. Condition of Containers N.A.
 5. Indication of Chemical Leakage N.A.
- H. Types and Characteristics of Wastes at Site
1. PAPER WASTES , TYPICAL DOMESTIC AND COMMERCIAL WASTES
 2. DOUBTFULL IF H.W. BEING TAKEN HERE.
 3. DOES HAVE A PERMIT BY KERN COUNTY AND E.P.A. (LAHONTOM)
- ~~A~~
- ~~B~~
- I. Other Information SEE SITE MAP FOR LOCATION
- J. Identification of Sources
1. SGT. WHITLOCK E.A.F.B.
 2. TERRY YONKERS E.A.F.B./C.E.
 3. SITE INSPECTION.

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name SOUTH BASE WASTE PETROLEUM, OIL & LUBRICANT (P.O.L.)
STORAGE AREA: SITE 5
- B. Site Location (OLD SOUTH BASE) SOUTH OF ORDINANCE RD./OFF
OLD HOSPITAL RD.
- C. Size/Area/Depth 4 (FOUR) UNDERGROUND STORAGE TANKS @ 50,000 GAL.
MOST LIKELY MADE OF S.S. EACH
- D. Dates of Operation TANKS INSTALLED MID 1940'S / STILL IN OPERATION.
- E. Method of Disposal UNDERGROUND STORAGE TANKS / 5' DEEP / SIZE 14' ϕ \times 45' LONG.
ALSO @ 70 DRUMS AT SITE.
- F. Site Physical Layout/Geographical Conditions FLAT / LOW ELEVATION / $1\frac{1}{2}$ MILES
FROM SHORE OF RODGERS DRY LAKEBED. FENCED AND POSTED NO TRESPASSING /
- G. Conditions at Site $\frac{3}{4}$ OF A MILE FROM WELL AND STORAGE
TANK,
1. Soil Condition NORMAL
2. Vegetation Present SOME
3. Water or Drainage Mechanisms Present NONE
4. Condition of Containers? 0 BARREL CONTAINERS GOOD / U.G. TANK - UNKNOWN
5. Indication of Chemical Leakage TANK #4 EMPTY NOW / KNOWN TO
HAVE LEAKED OUT. / SOME BARREL LEAKAGE.
- H. Types and Characteristics of Wastes at Site
1. #1 TANK - J.P. FUEL (AS POSTED.)
2. #2 TANK - WASTE GASOLINE, AVGAS, MOGAS (AS POSTED.)
3. #3 TANK - OIL AND FUEL (AS POSTED.)
4. #4 TANK - EMPTY
5. DRUMS CONTAIN FUEL AND LUBE OILS.
- I. Other Information SEE SITE MAP FOR LOCATION - SEE LABORATORY TEST
REPORT - ANALYSIS OF UNDERGROUND & DRUM STORAGE (8 JUL 80)
- J. Identification of Sources
1. TERRY YONKERS.
2. SITE INSPECTION.

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name ABANDONED MINE SHAFTS: SITE 6
- B. Site Location NORTHEAST BASE AREA, NEAR R.P.L.
- C. Size/Area/Depth 2 MINE SHAFTS / SIZE @ 12' x 12' x 200'-300' DEEP
- D. Dates of Operation USED AS DISPOSAL AREAS FROM MID 1950'S TO MID 1960'S
- E. Method of Disposal CYLINDERS MOSTLY DISPOSED OF AT THIS SITE.
- F. Site Physical Layout/Geographical Conditions FLAT AREA/HIGH ELEVATION
@ 2400 FT.
- G. Conditions at Site
1. Soil Condition N.A.
 2. Vegetation Present N.A.
 3. Water or Drainage Mechanisms Present NONE
 4. Condition of Containers. UNKNOWN - SHAFT #1 REPORTED TO HAVE BEEN
MINE SHAFTS FILLED IN AND COVERED WITH 20' SOIL - FENCED AND POSTED ON FIRE.
 5. Indication of Chemical Leakage N.A. REMOTE AREA - CONTROLLED ACCESS.
- H. Types and Characteristics of Wastes at Site
1. PENTABORANE
 2. H.E.F.-2, 3 (HIGH ENERGY FUEL)
 3. FLUORINE
 4. TETRAETHYL BORON
 5. HARDWARE AND OFFICE EQUIPMENT DISPOSED OF IN SHAFT #2.
- I. Other Information SEE SITE MAP FOR LOCATION
- J. Identification of Sources
1. RAY McDONALD E.A.F.B./FUEL MANAGEMENT
 2. TERRY YONKERS E.A.F.B./C.E.
 3. SITE INSPECTION

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name BERYLLIUM CONTAMINATED EARTH PILE (R.P.L.): SITE 7
- B. Site Location 300 YARDS NORTH OF WASTE FUELS TREATMENT FACILITY.
- C. Size/Area/Depth 300' L x 15' W. x 4' H.
- D. Dates of Operation SOIL FROM TEST GRID PATTERN PLACED THERE IN 1972. SOIL AND HARDWARE FROM BUILDING 9402 BERYLLIUM EXPLOSION
- E. Method of Disposal EARTHPILE AND HARDWARE DISPOSAL. PLACED THERE IN MID 1970'S.
- F. Site Physical Layout/Geographical Conditions EARTHPILE ON CREST OF GENTLY SLOPING RIDGE / RUNS N.E. TO S.W.
- G. Conditions at Site
 - 1. Soil Condition NORMAL.
 - 2. Vegetation Present YES
 - 3. Water or Drainage Mechanisms Present NO WATER, VERY LITTLE SIGNS OF WASH OUT.
 - 4. Condition of Containers N.A.
 - 5. Indication of Chemical Leakage N.A.
- H. Types and Characteristics of Wastes at Site
 - 1. HARDWARE CONTAMINATED WITH BERYLLIUM FROM FIRING PROGRAMS AND THE TOP 6" OF SOIL FROM THE WASTE FUELS TREATMENT FACILITY PROJECT SITE, PREVIOUS SITE OF TEST GRID PATTERN.
 - 2. BERYLLIUM CONTAMINATED SOIL AND HARDWARE RESULTING FROM THE EXPLOSION OF BUILDING 9402 IN MAY 1970.
- I. Other Information SEE SITE MAP FOR LOCATION.
- J. Identification of Sources
 - 1. CAPT. DENNIS REED E.A.F.B. / R.P.L.
 - 2. TED EVANS E.A.F.B. / R.P.L.
 - 3. SITE INSPECTION

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name INDUSTRIAL WASTE POND : SITE 8
- B. Site Location EAST OF FLIGHTLINE WITH EVAPORATION BASINS ON
RODGERS DRY LAKE.
- C. Size/Area/Depth
- D. Dates of Operation START - UP IN MID 1950'S.
- E. Method of Disposal POND WITH EARTH DYKES.
- F. Site Physical Layout/Geographical Conditions ON RODGERS LAKE.
- G. Conditions at Site
 - 1. Soil Condition N.A.
 - 2. Vegetation Present N.A.
 - 3. Water or Drainage Mechanisms Present WATER ALWAYS PRESENT
IN POND.
 - 4. Condition of Containers DYKES IN GOOD SHAPE.
 - 5. Indication of Chemical Leakage
- H. Types and Characteristics of Wastes at Site
 - 1. DRAINS FROM HANGERS, RUNWAY RUN-OFF AND WASH DOWN,
FUEL SPILLS, ALL ENTER THE POND. POND SERVES AS AN
EVAPORATION BASIN. FACILITY PERMITTED AND INSPECTED
BY KERN COUNTY.
 - 2.
 - 3.
- I. Other Information SEE SITE MAP FOR LOCATION.
- J. Identification of Sources
 - 1. SGT. WHITLOCK E.A.F.B.
 - 2. SITE INSPECTION

EDWARDS AIR FORCE BASE

I. WASTE DISPOSAL SITE FIELD DATA

- A. Site Name PETROLEUM SPILLAGE CONTAINMENT POND : SITE 9.
- B. Site Location 1/4 MILE N.W. FROM INTERSECTION OF FORBES AVE
AND ROSAMOND BLVD.
- C. Size/Area/Depth 30' L x 20' x 3' DEEP
- D. Dates of Operation START-UP UNKNOWN / PRESENTLY IN USE.
- E. Method of Disposal POND WITH EARTH DYKE WALLS.
- F. Site Physical Layout/Geographical Conditions GRADUAL SLOPE - TOWARD EAST.
- G. Conditions at Site
 - 1. Soil Condition ADDITIONAL SOIL BEING ADDED TO REINFORCE
THE DYKES.
 - 2. Vegetation Present N.A.
 - 3. Water or Drainage Mechanisms Present NONE.
 - 4. Condition of Containers N.A.
 - 5. Indication of Chemical Leakage NONE.
- H. Types and Characteristics of Wastes at Site
 - 1. DUST BINDER AND ASPHALTIC SEALER IN NEARBY STORAGE
TANKS. OVERFILL AND SPILLAGE FROM THESE TANKS CONTAINED
IN THE POND. WATER FROM WASHING OPERATION UPHILL
ALSO FLOWS INTO POND. CONTENTS OF POND - VERY
THICK EMULSION.
- I. Other Information SEE SITE MAP FOR LOCATION.
- J. Identification of Sources
 - 1. TERRY YONKERS E.A.F.B./C.E.
 - 2. CARMINE DELUCA E.A.F.B./C.E.
 - 3. SITE INSPECTION.

APPENDIX B
RATING SYSTEM SCORE SHEETS

APPENDIX B
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RATING FORM FOR WASTE DISPOSAL SITES

Site Name: North Lake Bed Disposal and Storage Site (west site): Subsite 1A					
Comments: (1 of 4 subsites)					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Remote area	1	5	5	15
2. Site Security	None	2	1	2	3
3. Method of Storage	55-gallon drums stored on the ground	2	3	6	9
4. Proximity of Drinking Water Well	Active well within 1 mile	3	4	12	12
5. Water or Drainage Mechanisms Present	Some drainage	2	3	6	9
				Subtotal	41
				Subscore %	65
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	Yes, soil darkened	2	3	6	9
2. Degree of Leakage or Spillage	Small amount	2	5	10	15
3. Depth to Groundwater/ Distance to Surface Water	Groundwater depth fairly close - 60 to 70 feet	2	2	4	6
4. Soil/Bed Rock Permeability	Very permeable - sandy soil at surface	3	4	12	12
5. Migration Mechanism Present	Leaching or direct percolation in a high recharge area	3	4	12	12
				Subtotal	44
				Subscore %	81

*1 = low, 2 = moderate, and 3 = high.

Site Name: North Lake Bed Disposal and Storage Site (west site), Subsite 1A

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Note: Hazard potential based on a wide variety of waste chemicals stored at this site including: motor oil, dry cleaning solvent, lube oil and miscellaneous cleaning compounds.	2	3	6	9
2. Corrosivity		1	3	3	9
3. Reactivity		1	3	3	9
4. Toxicity		2	5	10	15
5. Persistence		3	4	12	12
6. Solubility		1	4	4	12
7. Total Waste Quantity	Several hundred gallons	2	5	10	15
Subtotal				48	81
Subscore %					59
IV. Waste Management Practices					
1. Waste Incompatibility	Low	1	5	5	15
2. Use of Liners or Containment System	None used	2	3	6	9
3. Use of Leachate Collection or Monitoring Systems	None used	2	2	4	6
4. Condition of Containment System	Fair	2	4	8	12
Subtotal				23	42
Subscore %					55

V. Scoring	
Total Score	146
Maximum Possible Score	225
Overall Score %	65

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: North Lake Bed Disposal and Storage Site (drum storage): Subsite 1B					
Comments: (1 of 4 subsites) Two drum storage areas					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Remote area	1	5	5	15
2. Site Security	Area posted, however no fences	2	1	2	3
3. Method of Storage	55-gallon drums stored on the ground	2	3	6	9
4. Proximity of Drinking Water Well	Active wells within three-quarters of a mile	3	4	12	12
5. Water or Drainage Mechanisms Present	Approximately 100 drums stored on lakebed. Not frequently contacted with surface water during rainy season.	2	3	6	9
				Subtotal	48
				Subscore %	65
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	Little barrel leakage	1	3	3	9
2. Degree of Leakage or Spillage	Slight	1	5	5	15
3. Depth to Groundwater/Distance to Surface Water	Depth to groundwater 60 to 70 feet	2	2	4	6
4. Soil/Bed Rock Permeability	Low permeability soil - based on clays	1	4	4	12
5. Migration Mechanism Present	Leaching or direct percolation	1	4	4	12
				Subtotal	54
				Subscore %	37

*1 = low, 2 = moderate, and 3 = high.

Site Name: North Lake Bed Disposal and Storage (Drum storage): Subsite 1B

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Aniline as basis	2	3	6	9
2. Corrosivity	Note: Hazard potential based on a wide variety of waste chemicals stored at this site including insulating oil, cleaning alcohol and aniline.	2	3	6	9
3. Reactivity		1	3	3	9
4. Toxicity	Aniline as basis	3	5	15	15
5. Persistence		2	4	8	12
6. Solubility		2	4	8	12
7. Total Waste Quantity	Unknown	3	5	15	15
		Subtotal		61	81
		Subscore %			75
IV. Waste Management Practices					
1. Waste Incompatibility	Low	1	5	5	15
2. Use of Liners or Containment System	Natural clay deposits act as liner	1	3	3	9
3. Use of Leachate Collection or Monitoring Systems	None used	3	2	6	6
4. Condition of Containment System	Fair	2	4	8	12
		Subtotal		22	42
		Subscore %			52

V. Scoring	
Total Score	134
Maximum Possible Score	225
Overall Score %	60

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: North Lake Bed Disposal and Storage Site (Nitric acid trenches): Subsite 1C					
Comments: (1 of 4 subsites)					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum possible Score
I. Site Evaluation					
1. Site Location	Remote area	1	5	5	15
2. Site Security	Area posted, however no fences	2	1	2	3
3. Method of Storage	Chemicals poured out onto the ground	3	3	9	9
4. Proximity of Drinking Water Well	Active wells within three-quarters of a mile	3	4	12	12
5. Water or Drainage Mechanisms Present	None	1	3	3	9
Subtotal				31	48
Subscore %				65	
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	Yes, ground discolored, void of vegetation, sunken	3	3	9	9
2. Degree of Leakage or Spillage	Large amounts over the 10-year period of operation	3	5	15	15
3. Depth to Groundwater/ Distance to Surface Water	Depth to groundwater - 60 to 70 feet	2	2	4	6
4. Soil/Bed Rock Permeability	Low permeability? Underlying clay deposits	1	4	4	12
5. Migration Mechanism Present	Direct percolation	2	4	8	12
Subtotal				40	54
Subscore %				74	

*1 = low, 2 = moderate, and 3 = high.

Site Name: North Lake Bed Disposal and Storage Site (Nitric acid trenches): Subsite 1C

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	NOTE: Hazard potential based on fuming red and white nitric acids	1	3	3	9
2. Corrosivity		2	3	6	9
3. Reactivity		1	3	3	9
4. Toxicity		1	5	5	15
5. Persistence		2	4	8	12
6. Solubility		3	4	12	12
7. Total Waste Quantity	Possibly large amounts	3	5	15	15
Subtotal				52	81
Subscore %					64
IV. Waste Management Practices					
1. Waste Incompatibility	Moderate	2	5	10	15
2. Use of Liners or Containment System	Natural clay deposits act as liner	1	3	3	9
3. Use of Leachate Collection or Monitoring Systems	None used	3	2	6	6
4. Condition of Containment System	No containment	3	4	12	12
Subtotal				31	42
Subscore %					74

V. Scoring	
Total Score	154
Maximum Possible Score	225
Overall Score %	68

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: North Lake Bed Disposal and Storage Site (Barrel trenches): Subsite 1D					
Comments: (1 of 4 subsites) Two barrel trenches					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Remote area	1	5	5	15
2. Site Security	Area posted, however no fences	2	1	2	3
3. Method of Storage	Barrels dumped into trenches	3	3	9	9
4. Proximity of Drinking Water Well	Active wells within three-quarters of a mile	3	4	12	12
5. Water or Drainage Mechanisms Present	Sidewalls show runoff washing into trenches	3	3	9	9
				Subtotal	37
				Subscore %	77
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	Many of the barrels are empty	3	3	9	9
2. Degree of Leakage or Spillage	Possibly a large amount	3	5	15	15
3. Depth to Groundwater/Distance to Surface Water	Depth to groundwater - 60 to 70 feet. Surface water drainage into this area.	3	2	6	6
4. Soil/Bed Rock Permeability	Low permeability due to underlying clay deposits	1	4	4	12
5. Migration Mechanism Present	Leaching and direct percolation	3	4	12	12
				Subtotal	46
				Subscore %	85

*1 = low, 2 = moderate, and 3 = high.

Site Name: North Lake Bed Disposal and Storage Site (Barrel trenches): Subsite 1D

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
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III. Waste Characteristics

1. Ignitability	Note: Hazard potential based on a wide variety of waste chemicals stored at this site including: engine cleaner, furfuryl alcohol, ethyl alcohol and aniline.	2	3	6	9
2. Corrosivity		2	3	6	9
3. Reactivity		1	3	3	9
4. Toxicity	Aniline as basis	3	5	15	15
5. Persistence		2	4	8	12
6. Solubility		2	4	8	12
7. Total Waste Quantity	Several ten thousands of gallons	3	5	15	15
Subtotal				61	81
Subscore %					75

IV. Waste Management Practices

1. Waste Incompatibility	High	3	5	15	15
2. Use of Liners or Containment System	Natural clay deposits act as liner	1	3	3	9
3. Use of Leachate Collection or Monitoring Systems	None used	3	2	6	6
4. Condition of Containment System	Poor	3	4	12	12
Subtotal				36	42
Subscore %					85

V. Scoring

Total Score	180
Maximum Possible Score	225
Overall Score %	80

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: Main Base Toxic Waste Disposal Site: Site 2					
Comments: Located north of Mojave Avenue/east of Lancaster Road					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Near traffic routes	1	5	5	15
2. Site Security	Fenced, locked gate, posted	1	1	1	3
3. Method of Storage	Buried containers and/or poured out onto the ground	3	3	9	9
4. Proximity of Drinking Water Well	One well within 3 miles	1	4	4	12
5. Water or Drainage Mechanisms Present	Little drainage	1	3	3	9
				Subtotal	48
				Subscore %	46
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	Yes, discolored ground	3	3	9	9
2. Degree of Leakage or Spillage	Possibly large amounts	3	5	15	15
3. Depth to Groundwater/Distance to Surface Water	Thin soils, no aquifers in this area	1	2	2	6
4. Soil/Bed Rock Permeability	Coefficient of permeability high based on sandy soils	3	4	12	12
5. Migration Mechanism Present	Leaching	1	4	4	12
				Subtotal	54
				Subscore %	78

*1 = low, 2 = moderate, and 3 = high.

Site Name: Main Base Toxic Waste Disposal Site: Site 2

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	JP-5 as basis	3	3	9	9
2. Corrosivity	Nitric acid as basis	3	3	9	9
3. Reactivity	Nitric acid as basis	3	3	9	9
4. Toxicity	Cyanide as basis	3	5	15	15
5. Persistence	Heavy metals as basis	3	4	12	12
6. Solubility	Nitric acid as basis	3	4	12	12
7. Total Waste Quantity	Possibly large amounts	3	5	15	15
Subtotal				81	81
Subscore %				100	

IV. Waste Management Practices					
1. Waste Incompatibility	High	3	5	15	15
2. Use of Liners or Containment System	None used	3	3	9	9
3. Use of Leachate Collection or Monitoring Systems	None used	3	2	6	6
4. Condition of Containment System	None used or unknown	3	4	12	12
Subtotal				42	42
Subscore %				100	

V. Scoring	
Total Score	187
Maximum Possible Score	225
Overall Score %	83

*1 = low, 2 = moderate, and 3 = high.

B10

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: Abandoned Main Base Sanitary Landfill: Site 3

Comments: Located near intersection of Forbes and Mojave Boulevards

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Near traffic routes	2	5	10	15
2. Site Security	No fence - open area	3	1	3	3
3. Method of Storage	Landfill	2	3	6	9
4. Proximity of Drinking Water Well	No wells in this area	1	4	4	12
5. Water or Drainage Mechanisms Present	None	1	3	3	9
Subtotal				26	48
Subscore %					54
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	None detectable by surface investigation	1	3	3	9
2. Degree of Leakage or Spillage	None detectable by surface investigation	1	5	5	15
3. Depth to Groundwater/ Distance to Surface Water	Near surface water based on arroyo	2	2	4	6
4. Soil/Bed Rock Permeability	Coefficient of permeability high - based on sandy soils	3	4	12	12
5. Migration Mechanism Present	Leaching	1	4	4	12
Subtotal				28	54
Subscore %					53

*1 = low, 2 = moderate, and 3 = high.

Site Name: Abandoned Main Base Sanitary Landfill: Site 3

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Note: The hazard potential is based on the possibility that hazardous wastes and banned pesticides were co-disposed with domestic sanitary wastes.	3	3	9	9
2. Corrosivity		2	3	6	9
3. Reactivity		2	3	6	9
4. Toxicity		3	5	15	15
5. Persistence		3	4	12	12
6. Solubility		2	4	8	12
7. Total Waste Quantity	Large amounts	3	5	15	15
Subtotal				71	81
Subscore %					88

IV. Waste Management Practices

1. Waste Incompatibility	Based on possibility of co-disposal - high	3	5	15	15
2. Use of Liners or Containment System	Unknown	2	3	6	9
3. Use of Leachate Collection or Monitoring Systems	None used	3	2	6	6
4. Condition of Containment System	Fair	2	4	8	12
Subtotal				35	42
Subscore %					83

V. Scoring

Total Score	160
Maximum Possible Score	225
Overall Score %	71

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: Active Main Base Sanitary Landfill: Site 4					
Comments: Located adjacent to abandoned main base sanitary landfill					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Located at limited use dead-end road	1	5	5	15
2. Site Security	Fenced and posted	1	1	1	3
3. Method of Storage	Sanitary landfill	1	3	4	12
4. Proximity of Drinking Water Well	None in area	1	4	4	12
5. Water or Drainage Mechanisms Present	None	1	3	3	9
Subtotal				16	48
Subscore %					33
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	None detectable by surface investigation	1	3	3	9
2. Degree of Leakage or Spillage	None detectable by surface investigation	1	5	5	15
3. Depth to Groundwater/ Distance to Surface Water	Near surface water based on arroyo	2	2	4	6
4. Soil/Bed Rock Permeability	Coefficient of permeability high - based on sandy soils	3	4	12	12
5. Migration Mechanism Present	Leaching	1	4	4	12
Subtotal				28	54
Subscore %					52

*1 = low, 2 = moderate, and 3 = high.

Site Name: Active Main Base Sanitary Landfill: Site 4

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Note: The hazard potential is based on disposal of typical domestic and commercial wastes.	2	3	6	9
2. Corrosivity		1	3	3	9
3. Reactivity		1	3	3	9
4. Toxicity		2	5	10	15
5. Persistence		2	4	8	12
6. Solubility		2	4	8	12
7. Total Waste Quantity	Large Amounts	3	5	15	15
				Subtotal	53
				Subscore %	81
IV. Waste Management Practices					
1. Waste Incompatibility	Low	1	5	5	15
2. Use of Liners or Containment System	Unknown	1	3	3	9
3. Use of Leachate Collection or Monitoring Systems	None used	2	2	4	6
4. Condition of Containment System	Well operated	1	4	4	12
				Subtotal	16
				Subscore %	42

V. Scoring	
Total Score	113
Maximum Possible Score	225
Overall Score %	50

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: South Base Waste Petroleum, Oils, and Lubricants (P.O.L.) Storage: Site 5					
Comments: Located near Old South Base/off Old Hospital Road					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Near abandoned Old South Base	2	5	10	15
2. Site Security	Cyclone fenced, posted	1	1	1	3
3. Method of Storage	Underground Storage Tanks	2	3	6	9
4. Proximity of Drinking Water Well	Within three-quarters of a mile	3	4	12	12
5. Water or Drainage Mechanisms Present	None	1	3	3	9
				Subtotal	48
				Subscore %	67
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	Tank No. 4 has leaked out	3	3	9	9
2. Degree of Leakage or Spillage	Quantity unknown-maximum 50,000 gal	3	5	15	15
3. Depth to Groundwater/Distance to Surface Water	Shallow depth to groundwater	2	2	4	6
4. Soil/Bed Rock Permeability	Soil permeability Moderate	2	4	8	12
5. Migration Mechanism Present	Direct percolation	2	4	8	12
				Subtotal	54
				Subscore %	81

*1 = low, 2 = moderate, and 3 = high.

Site Name: South Base Waste Petroleum, Oils, and Lubricants (P.O.L.) Storage: Site 5

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	AVGAS as basis	3	3	9	9
2. Corrosivity	Petroleum compounds as basis	1	3	3	9
3. Reactivity	Petroleum compounds as basis	1	3	3	9
4. Toxicity	Petroleum compounds as basis	1	5	5	15
5. Persistence	Petroleum compounds as basis	2	4	8	12
6. Solubility	Petroleum compounds as basis	1	4	4	12
7. Total Waste Quantity	22,000 gal AVGAS/MOGAS/Water 30,000 gal JP Fuel/Water 4,000 gal Syn Ester Oil	3	5	15	15
Subtotal				47	81
Subscore %				58	
IV. Waste Management Practices					
1. Waste Incompatibility	Wastes are separated	1	5	5	15
2. Use of Liners or Containment System	None used	2	3	6	9
3. Use of Leachate Collection or Monitoring Systems	None used	2	2	4	6
4. Condition of Containment System	Tank approximately 40 years old. Tank 4 has leaked	3	4	12	12
Subtotal				27	42
Subscore %				64	

V. Scoring	
Total Score	150
Maximum Possible Score	225
Overall Score %	67

*1 = low 2 = moderate and 3 = high.

B16

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: Abandoned Mine Shafts: Site 6					
Comments: Located at Rocket Propulsion Laboratory					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Very remote area	1	5	5	15
2. Site Security	Fenced	1	1	1	3
3. Method of Storage	Deep underground disposal	2	3	6	9
4. Proximity of Drinking Water Well	No wells in the area	1	4	4	12
5. Water or Drainage Mechanisms Present	Possible groundwater	1	3	3	9
				Subtotal	48
				Subscore %	40
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	None detectable by surface investigation	1	3	3	9
2. Degree of Leakage or Spillage	Possibly large amounts	2	5	10	15
3. Depth to Groundwater/Distance to Surface Water	No groundwater in this area	1	2	2	6
4. Soil/Bed Rock Permeability	Very low permeability based on bedrock	1	4	4	12
5. Migration Mechanism Present	Leaching	1	4	4	12
				Subtotal	54
				Subscore %	43

*1 = low, 2 = moderate, and 3 = high.

Site Name: Abandoned Mine Shafts: Site 6

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Pentaborane as basis	3	3	9	9
2. Corrosivity	Fluorine as basis	3	3	9	9
3. Reactivity	Fluorine and pentaborane as basis	3	3	9	9
4. Toxicity	Fluorine and pentaborane as basis	3	5	15	15
5. Persistence	Pentaborane as basis	2	4	8	12
6. Solubility	Fluorine as basis	2	4	8	12
7. Total Waste Quantity	Possibly large amounts over the 10 years of operation. However, much of this thought to have been ignited or combusted.	3	5	15	15
Subtotal				73	81
Subscore %				90	
IV. Waste Management Practices					
1. Waste Incompatibility	High	3	5	15	15
2. Use of Liners or Containment System	None used	2	3	6	9
3. Use of Leachate Collection or Monitoring Systems	None used	2	2	4	6
4. Condition of Containment System	Unknown	2	4	8	12
Subtotal				33	42
Subscore %				79	

V. Scoring	
Total Score	148
Maximum Possible Score	225
Overall Score %	66

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: Beryllium Contaminated Earth Pile (RPL): Site 7					
Comments: Located at Rocket Propulsion Laboratory					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Remote area	2	5	10	15
2. Site Security	Single strand barbed wire	2	1	2	3
3. Method of Storage	Earth pile	1	3	3	9
4. Proximity of Drinking Water Well	No wells in the area	1	4	4	12
5. Water or Drainage Mechanisms Present	Surface runoff or wind blown carry off	2	3	6	9
				Subtotal	48
				Subscore %	52
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	None detectable by visual investigation	1	3	3	9
2. Degree of Leakage or Spillage	Possibly large amounts	2	5	10	15
3. Depth to Groundwater/ Distance to Surface Water	No groundwater in this area	1	2	2	6
4. Soil/Bed Rock Permeability	Very low based on bedrock	1	4	4	12
5. Migration Mechanism Present	Leaching	1	4	4	12
				Subtotal	54
				Subscore %	43

*1 = low, 2 = moderate, and 3 = high.

Site Name: Beryllium Contaminated Earth Pile (RPL): Site 7

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Note: Hazard potential evaluation based on beryllium.	1	3	3	9
2. Corrosivity		2	3	6	9
3. Reactivity		1	3	3	9
4. Toxicity		3	5	15	15
5. Persistence		3	4	12	12
6. Solubility		1	4	4	12
7. Total Waste Quantity	Total amount of Beryllium not very much, however Beryllium is toxic in very small amounts.	2	5	10	15
Subtotal				53	81
Subscore %				65	
IV. Waste Management Practices					
1. Waste Incompatibility	Low	1	5	5	15
2. Use of Liners or Containment System	None used	2	3	6	9
3. Use of Leachate Collection or Monitoring Systems	None used	2	2	4	6
4. Condition of Containment System	None used	2	4	8	12
Subtotal				23	42
Subscore %				55	

V. Scoring	
Total Score	124
Maximum Possible Score	225
Overall Score %	55

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: Industrial Waste Pond: Site 8					
Comments: Located east of Flight Line					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Off flight line	1	5	5	15
2. Site Security	No fence, but a berm	1	1	1	3
3. Method of Storage	Surface impoundment	1	3	3	9
4. Proximity of Drinking Water Well	One well within 2 miles	1	4	4	12
5. Water or Drainage Mechanisms Present	On Rodgers Lake; water present during rainy season	1	3	3	9
				Subtotal	48
				Subscore %	33
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	None detectable by surface investigation	1	3	3	9
2. Degree of Leakage or Spillage	None detectable by surface investigation	1	5	5	15
3. Depth to Groundwater/ Distance to Surface Water	Very near surface water during rainy season	2	2	4	6
4. Soil/Bed Rock Permeability	Moderate - based on year-round ponding	2	4	8	12
5. Migration Mechanism Present	Direct percolation	3	4	12	12
				Subtotal	54
				Subscore %	59

*1 = low, 2 = moderate, and 3 = high.

Site Name: Industrial Waste Pond: Site 8

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Note: Hazard potential based on a wide variety of waste chemicals contained at this site including: runway run-off and washdown, fuel spills and hanger washdown.	2	3	6	9
2. Corrosivity		1	3	3	9
3. Reactivity		1	3	3	9
4. Toxicity		2	5	10	15
5. Persistence		1	4	4	12
6. Solubility		1	4	4	12
7. Total Waste Quantity	Total amount large, however much of this is water	2	5	10	15
Subtotal				40	81
Subscore %				49	

IV. Waste Management Practices					
1. Waste Incompatibility	Low	1	5	5	15
2. Use of Liners or Containment System	Lakebed utilized as impervious liner	1	3	3	9
3. Use of Leachate Collection or Monitoring Systems	None used	2	2	4	6
4. Condition of Containment System	Dykes in fair condition	2	4	8	12
Subtotal				20	42
Subscore %				48	

V. Scoring	
Total Score	108
Maximum Possible Score	225
Overall Score %	48

*1 = low, 2 = moderate, and 3 = high.

RATING FORM FOR WASTE DISPOSAL SITES

Site Name: Petroleum Spillage Containment Pond: Site 9					
Comments: Located near intersection of Forbes and Rosamond					
Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
I. Site Evaluation					
1. Site Location	Located on sloping ground above grade	2	5	10	15
2. Site Security	Actual pond is not fenced or posted	3	1	3	3
3. Method of Storage	Surface impoundment	2	3	6	9
4. Proximity of Drinking Water Well	No wells in this area	1	4	4	12
5. Water or Drainage Mechanisms Present	Surface runoff can enter pond	1	3	3	9
				Subtotal	48
				Subscore %	54
II. Potential for Contamination					
1. Evidence of Chemical Leakage or Spillage	None outside of pond area	1	3	3	9
2. Degree of Leakage or Spillage	None detectable by surface investigation	1	5	5	15
3. Depth to Groundwater/ Distance to Surface Water	Thin soils, no aquifers in this area	1	2	2	6
4. Soil/Bed Rock Permeability	Coefficient of permeability high - based on sandy soil	3	4	12	12
5. Migration Mechanism Present	Leaching	1	4	4	12
				Subtotal	54
				Subscore %	48

*1 = low, 2 = moderate, and 3 = high.

Site Name: Petroleum Spillage Containment Pond: Site 9

Rating Factor	Comments	Hazard Potential*	Weighting Factor (1-5)	Score	Maximum Possible Score
III. Waste Characteristics					
1. Ignitability	Note: Characteristics based on asphaltic sealer	2	3	6	9
2. Corrosivity		1	3	3	9
3. Reactivity		1	3	3	9
4. Toxicity		2	5	10	15
5. Persistence		2	4	8	12
6. Solubility		1	4	4	12
7. Total Waste Quantity	More than 10,000 gallons	3	5	15	15
				Subtotal	49
				Subscore %	60
IV. Waste Management Practices					
1. Waste Incompatibility	Low	1	5	5	15
2. Use of Liners or Containment System	Unknown	2	3	6	9
3. Use of Leachate Collection or Monitoring Systems	None used	2	2	4	6
4. Condition of Containment System	Dike walls being rebuilt	2	4	8	12
				Subtotal	23
				Subscore %	55

V. Scoring	
Total Score	124
Maximum Possible Score	225
Overall Score %	55

ADDENDUM 1

A meeting was held at Edwards Air Force Base (AFB) on April 16, 1981 to discuss the draft version of this report. A list of attendees is attached to this addendum.

The discussion centered around written comments prepared by the California Regional Water Quality Control Board, Lahontan Region (CRWQCB-Lahontan). These comments were submitted to Mr. Ralph N. Willbanks, Edwards AFB, on April 14, 1981. The comments, along with a summary of Envirodyne Engineers' (EEI) and Edwards AFB's responses are presented below.

COMMENT 1

Table 3 of the report, which lists the "rating scores" for each of the nine sites considered, shows high pollution threat scores for Site 2 (Main Base Toxic Waste Disposal Site), yet the report recommends a lower priority for cleanup and further investigation of Site 2 than it does for other sites with lower scores. It would appear that Site 2 should also be a Number 1 priority site according to the methodology used in the report to compare relative potentials of sites to contaminate groundwater.

EEI Response

EEI has recommended that certain positive follow-up actions be taken at both Priorities 1 and 2 sites. Edwards AFB personnel

have agreed that all Phase I recommended actions will be implemented concurrently, regardless of whether they are to be taken at Numbers 1 or 2 priority sites. Therefore, the recommendations themselves are much more important than the priority classification that was assigned to each site. EEI classified Site 2 (Main Base Toxic Waste Disposal Site) as a Number 2 priority site because we believe that the potential for groundwater contamination from this site has been less clearly demonstrated, and that even if such a potential does exist, the threat of contaminating an aquifer is not an imminent threat.

COMMENT 2

Site 7 (Beryllium Contaminated Earth Pile) is discussed on page 73 of the report, where the statement is made that the average concentration of beryllium oxide in the soil "is probably less than 10 ppm..." From this statement it appears that the soil may not have actually been sampled. We feel that soil sampling should be conducted at the site to determine actual beryllium concentrations.

EEI/Edwards AFB Response

Soil sampling has been conducted in regard to the Beryllium Contaminated Earth Pile. This laboratory data can be made available to CRWQCB-Lahontan if desired. The majority of the soil in the earth pile came from the rocket test firing area.

This area was sampled on a grid pattern prior to excavation. Fifty soil samples were collected from random points within the sampling grid. A small portion of the soil in the earth pile came from an area surrounding a building which exploded. This soil was also sampled prior to excavation.

Since the earth pile itself was not quantitatively sampled to determine the beryllium content, the exact average beryllium concentration is not known. However, based on results of the soil analyses, EEI is confident that our estimate of 10 ppm is conservative and that the actual average concentration of beryllium in the earth pile is less than 10 ppm.

COMMENTS 3

Further definition of the problem at the abandoned mine shafts (Site 6) is needed. The conclusion that no further investigation or remedial action is necessary at the site seems inappropriate when so little is known about the amounts and types of wastes that were disposed of at the site.

EEI Response

EEI believes that sufficient information was obtained concerning the types, quantities, and methods of disposal of wastes at the abandoned Mine Shafts in order to reach the conclusions drawn in the report. This information indicated that large quantities of highly flammable, toxic wastes were

disposed of at the mine shafts and that these wastes were occasionally ignited. Based on this information, we believe that it is imperative that these contaminants be confined to a very secure disposal site. Our analysis of the abandoned mine shafts indicated that they constitute a very secure disposal site.

At the meeting held at Edwards AFB, it was mentioned that although the bedrock at the abandoned mine shaft sites is not permeable enough to be considered an aquifer, there often is some secondary porosity/permeability in this igneous rock. EEI's analysis of the geologic reports concerning this bedrock unit indicated that any secondary porosity/permeability present would be quite low, and that, even using worst case assumptions, the abandoned mine shafts would still be considered very secure disposal sites. It was suggested that, since the wastes disposed of at the abandoned mine shafts are very toxic, the permeability of the bedrock in the vicinity of the shafts should be tested to assure that it is as low as has been assumed. EEI does not agree that this is necessary, since even if the bedrock has a moderate permeability, the distance to the nearest aquifer would provide excellent protection.

COMMENT 4

The report should contain a discussion of the possibility that radioactive wastes were disposed of at some of the sites.

Have there been any measurements taken of radioactivity levels at the subject sites?

EEI/Edwards AFB Response

Since the 1940s, radioactive wastes have been tightly controlled and regulated. The record searches and interviews conducted by EEI and Edwards AFB personnel never uncovered any evidence that radioactive research, testing or waste disposal was ever carried out at Edwards AFB. Because of this, radioactivity measurements at the subject sites do not seem warranted.

COMMENT 5

We recommend that the report contain a time schedule for completion of additional investigation, clean-up, and monitoring at the sites.

EEI/Edwards AFB Response

The following schedule for follow-up actions was prepared by Edwards AFB personnel and discussed at the meeting on April 16, 1981. This schedule was based on a similar, suggested schedule included in the CRWQCB-Lahontan's comments.

ADDITIONAL COMMENTS

Additional comments on the draft report are expected from Mr. Gil Torres, State Water Quality Control Board. These

comments were not received in time to incorporate them in this report. Verbal discussions of this report were made with Mr. Torres, and he apparently disagrees with some of EEI's recommendations. These disagreements will have to be addressed and resolved between Edwards AFB personnel and CRWQCB-Lahontan.

AIR FORCE TIME SCHEDULE FOR COMPLETING
FOLLOW-UP INVESTIGATIONS, CLEAN-UP AND MONITORING

<u>Task</u>	<u>Completion Date</u>
1) Complete Final EEI Report	May 15, 1981
2) Remove wastes/complete sampling as recommended in EEI Report	August 15, 1981
3) Complete analysis of samples	September 30, 1981
4) Develop plan for follow-up measures* and advise CRWQCB of actions to be taken	November 15, 1981
5) Install groundwater monitoring wells (as needed)	June 30, 1982
6) Develop a plan and schedule for follow-up measures** and advise CRWQCB of actions to be taken	No Date Set - Will depend on monitoring well results

*Follow-up measures depend upon results of soil, sediment, etc., samples.

**Follow-up measures depend upon results from samples taken from groundwater monitoring wells.

ATTENDEES AT MEETING HELD AT EDWARDS AFB (April 16, 1981)

<u>Name</u>	<u>Title</u>	<u>Location</u>	<u>Telephone</u>
Maj. Gary Fishburn	Chief Water Qual. Branch USAF OEHL/ECW	Brooks AFB, TX	AV 240-3305 512-536-3305
Bernard Lindenberg	Environmental Engineer AFESC/DEVP	Tyndall AFB, FL	AV 970-6189 904-283-6189
Lt. Col. M. R. Good	AFFTC Staff Bioenvironmental Engineer	Edwards AFB, CA	805-277-3272
Neil E. Rochelle	HQ AFSC/DEV	Andrews AFB	AV 858-6341 301-981-6341
Donald R. Monnot	Sr. Environmental Scientist	EEI, St. Louis	314-434-6960
Mark H. Kroenig	Sr. Environmental Engineer	EEI, St. Louis	314-434-6960
Terry Yonkers	AFFTC Environmental Coordinator	Edwards AFB, CA	805-277-4730
Jim Baker	Bioenvironmental Engineer USAF HOSP/SGPB	Edwards AFB, CA	805-277-3272
Capt. Lynn Ashley	AFFTC/TA	Edwards AFB, CA	805-277-4310
Jack A. Yamauchi	AFFTC Civil Engineering	Edwards AFB, CA	805-277-4730
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Bob Dodds	District Engineer	Lahontan RWQCB- Victorville	714-245-6583
Roy C. Hampson	Executive Officer	Lahontan RWQCB	916-544-3481
Paul F. Christensen	V.C.	Lahontan RWQCB	714-252-3350
Gil Torres	Sr. Engineering Geologist	Sacramento, CA	916-445-7762
Maj. Dennis A. Reed	AFRPL/SE	Edwards AFB, CA	805-277-5135